DIMENSIONS NBS

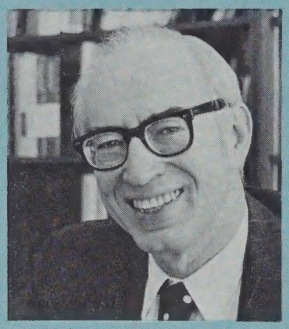
The magazine of the National Bureau of Standards, U.S. Department of Commerce

April 1977

PROBING THE OCEAN DEPTHS. See Page 12.

COMMENT

STANDARDS FOR INDUSTRIALIZING NATIONS



Coming of age as an industrialized society is a complex process. A nation must develop all the interrelated systems necessary to produce products that can compete in the international marketplace. Not least among these systems is one for determining and maintaining standards for equity and quality control in industry and commerce.

Awareness of the need for a legal basis for such standards and for a national focal point to carry out the mandate is becoming widespread. Developing nations learn through advice from highly industrialized countries and through hard experience. Rejection of products by potential buyers is a vote of no confidence, and manufactured goods that fail in service are certain to breed international hard feelings.

Awareness, however, is just the beginning. Once the legal mechanisms are established, the question is how to proceed. How does one organize weights and measures regulatory procedures? What kinds of standards are needed? What services should be provided to industry and to the consumer? What do such services cost and how can they be financed?

To further complicate the matter, each nation has its own unique system for dealing with these questions: The anatomy of every national standards organization is different from all others. Intra-governmental relationships vary greatly. However, underlying the superstructure of all such systems is a basic foundation of science and technology common to all. It is this infrastructure that is the special competence of the National Bureau of Standards.

For many years, NBS used this competence to assist developing nations on an ad hoc basis, with financial support from the U.S. Agency for International Development (AID). In 1971, these efforts were carefully aggregated into an experimental program, still continuing. The aim is to determine how NBS can assist developing nations most effectively.

The program consists of several activities:

(1) Workshops in the United States at which staff members from NBS and other federal agencies discuss the technical infrastructure services in the U.S. with officials from participating countries. Foreign participants are then given an orientation tour of related activities in the private sector.

(2) Survey missions to selected countries, in which needs for metrological and standardization services are examined and existing local capabilities identified by a team of advisers from NBS and other participating countries.

(3) Distribution of U.S. standards literature.

(4) Distribution of NBS Standard Reference Materials.

(5) Evaluation of the impact of NBS activities on the capabilities of participating countries.

This program has stimulated the development of standards organizations in less developed countries of Asia, Latin America, and Africa. By assisting these nations, we do not simply help them industrialize; we also help make them better trading partners to the United States.

Edward L. Brady

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Associate Director for Information Programs

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Contents

TELEVISION WATCHING COULD BECOME MEANINGFUL

Most TV Programs Don't Say a Thing to Millions of Americans— But That May Change

MILLIONS of Americans find television virtually meaningless. You can share their point of view: Tune in your favorite program and then turn off the sound.

Unless you are deaf or suffer a severe hearing impairment, you have probably given little thought to what that disability implies.

Beyond the fundamental problem of communicating with people who hear lie more subtle problems. The deaf cannot hear fire alarms or sirens. They cannot use a telephone without an interpreter. And, with the exception of a few programs, they cannot enjoy television, our single most important communications medium.

But television watching could become a meaningful experience to millions of deaf Americans, in large part because of a new TV captioning system developed by the Time and Frequency Division of the National Bureau of Standards.

Captioning—the addition of "subtitles" to render spoken dialogue in print—has been in limited use for some time. A few private-network evening news programs and several programs on the Public Broadcasting Service (PBS) have been captioned for years, but such "open" captioning is employed sparingly because, for the vast hearing majority in the country, captions are a nuisance on the TV screen.

However, in 1971 NBS demonstrated a "closed" captioning system. The program captions were encoded in the television broadcast signal and could be seen only on a TV set equipped with a special decoder.

Originally this system was called "TvTime." The NBS Time and Frequency Division had found that the national television networks broadcast extremely stable signals that could carry time and frequency information with a high degree of accuracy. The researchers developed a way of encoding this information on the so-called "vertical interval," a normally unused part of the television signal (see box).

In October, 1971, TvTime was tested over the ABC-TV network in New York City. Besides transmitting a standard frequency, the system displayed the time on the screen and sent written messages to other ABC affiliates and to the NBS time and frequency laboratories in Boulder, Colorado. At the suggestion of ABC-TV it was decided to try using TvTime to carry captions for the deaf.

NBS and ABC-TV first demonstrated the closed captioning system in December, 1971, at a National Conference on Television for the Hearing Impaired, which was sponsored by the HEW Division of Media Services and Captioned Films at the University of Tennessee in Knoxville. Conference attendees saw an episode of ABC-TV's "The Mod Squad" broadcast with closed captions. The response was, as PBS later noted, "most favorable." One visitor at the conference wrote, "The National Bureau of Standards' demonstration . . . was the highlight of the conference. This technical breakthrough might be considered the 'moon shot' for the millions who never heard the words 'one small step for man, one giant step for mankind.' "

A second demonstration was held the following February at Gallaudet College, Washington, D.C.'s famous school for the deaf and hearing impaired. The early captioning experiments were fairly crude, according to Sandy Howe, an information specialist with the NBS Time and Frequency Division who captioned a second episode of "The Mod Squad" for the Gallaudet demonstration. Working from an advance copy of the show's script, she spent two weeks coding the captions on a punched paper tape for transmission and "doing a lot of splicing and correcting misspelled words."

It played to an appreciative audience. Jim Jesperson, Chief of what was then the NBS Time and Frequency Dissemination Research Section, recalls: "Though the spectators were enthusiastic, nothing could match the growing excitement of the students as a whole new world opened up to them. Many motioned to each other with their hands; others had tears in their eyes as they watched the show. For the first time, they could actually understand the story."

In December of 1972, the Secretary of Commerce, on behalf of NBS, submitted a petition to the Federal Communications Commission (FCC), which would have to approve the use of time and program captions for broadcasts. The petition won the support of some industry and professional committees and several Congressmen, and it won the opposition of the three major networks, which argued that the proposed system needed more development and that the vertical interval space could be put to better use.

The captioning demonstrations and the FCC petition stimulated widespread interest in closed captioning, especially among the deaf and hearing impaired, and the Time and Frequency Division was deluged with requests for information. One teacher wrote, "We are greatly interested in what you have

turn page

UPDATE

After this issue of DIMENSIONS/NBS went into production, two events occurred that may improve the prospects for closed captioning:

1. During the week of February 20, President Carter wrote a letter to the television networks, urging them to consider the needs of deaf and hearing-impaired TV viewers. He cited the closed-captioning system discussed in this article.

2. Frederick S. Pierce, president of ABC, replied in writing, stating that ABC ". . . supports the prompt development of a reliable and flexible program captioning system which can be implemented at a reasonable cost."

Pierce suggests that a ". . . senior official of the federal government, perhaps the Secretary of HEW or his representative . . ." organize a group of representatives from the TV networks, the labor unions representing technical and creative employees in the program production industries, the electronics industry, government, and others to join forces to develop a captioning system.

to offer. I have been in special education for over 37 years and this could be the greatest 'breakthrough' for deaf education that has ever come about." The Smithsonian Institution included the TvTime system in a 1973 exhibit on "Communication Barriers to the Handicapped" and originally scheduled it for a one year display. It is still being seen by thousands of visitors.

Meanwhile, the Public Broadcasting Service became interested in the closed caption system. Over a three-year period, with funding from HEW and assistance from NBS, PBS technicians refined the system to make it more compatible with day-to-day programming. PBS modifications included some technical changes in the transmission format and improvements in the way the captions were displayed, such as the use of both upper and lower case letters. PBS also developed a mini-computer system to make it easier for a non-technical person to do the captioning.

A new petition, based on the PBS refinements, was submitted to the FCC in November, 1975, and the NBS petition was withdrawn to prevent confusion. The PBS petition came to the attention of President Ford, who directed the Office of Telecommunications Policy to "meet with appropriate persons in the public and private sectors to encourage voluntary implementation of captioning."

The most recent development occurred on December 10, 1976, when a unanimous FCC voted to allow PBS and other broadcasters to begin closed captioning service on a permanent basis. "We look forward to the day when all persons who suffer hearing impairments will be able to enjoy television programming. The decision reached here should go a long way toward achieving that goal," the Commission said.

Commenting on the FCC decision, PBS president Lawrence K. Grossman touched on the one remaining major obstacle to closed captioning: "Now that the FCC has spoken affirmatively on the need to provide full television service to this substantial portion of the population, the burden falls on us—and on all broadcasters—to work with equipment manufactured in developing popularly-priced, off-the-shelf decoders within the means of every hearing-impaired person in the country. PBS is committed to that objective. It is now time for all broadcasters to get together on the necessity to make captioning a basic ingredient of virtually all television programming."

The problem will be marketing closed captioning. At present, there are about 13 operating decoders

This NBS-built decoder shows how the computer synchronizes the captions to the program video type. Captions for the program—a dramatization of Dickens' David Copperfield—appear on the upper screen in sets of four. At the touch of a button, the lowermost caption appears on the bottom screen, showing how it will look on the video tape, and a new caption appears on the upper screen.

Closed-captioning pioneers include information specialist Sandra Howe who captioned television shows to demonstrate the NBS caption decoder and engineer Dick Davis who supervised construction of the units

in the country, all test models constructed for PBS under the supervision of NBS electrical engineer Dick Davis. PBS is currently looking for manufacturers who are interested in building and marketing the decoders—possibly built into special television receivers. But one of the opponents of the closed captioning petition was the Consumer Electronics Group of the Electronic Industries Association, a trade group representing all of the major manufacturers of television receivers.

Another question is whether or not the decoders —if built—would be used. Opponents of the PBS plan argue that it is only of value to the profoundly deaf—those who hear nothing—or to those with very severe cases of hearing impairment. This is closer to about 2 million than the often quoted 13.4 million figure which includes many people who have a hearing loss to some lesser degree. Persons who only suffer a degree of hearing loss would be better served by sound amplifiers, according to one argument. Proponents—including the National Association of the Deaf—reply that the sound distortion suffered by many of the partially deaf makes sound amplification useless for practical purposes.

The true figure for the number of hearing impaired people who need captions to understand TV is probably much greater than 1.8 million, the number of profoundly deaf, but under 6.5 million, the number of people with some degree of hearing loss in both ears, according to Marcus Delk, Jr., of New York University's Deafness Research and Training Center.

The number of persons who would use the system will affect the cost of the decoders if they are marketed. PBS estimates the added cost (above the normal retail cost of a TV set) at about $100—a figure which is also contested.

For the decoders to be useful, there must be programming carrying the coded captions. The only broadcaster currently doing this is PBS, which beams a couple of hours of captioned programming a week to the handful of test decoders installed in institutions for the hearing impaired throughout the country.

Of course, as decoders become available, the "market" for captioned programming will develop simultaneously. The reluctance on the part of industry today to capitalize on this innovation is reminiscent of the chicken/egg quandary of the early days of color television: Manufacturers felt that consumers wouldn't buy color sets until a significant number of programs were being broadcast in color; broadcasters thought it wasn't worthwhile to produce color shows until a significant number of viewers owned color TV's.

Today, captioned shows are mostly major-series programs carried by PBS. "The Adams Chronicles," for example, was broadcast with closed captions, as were some productions of the BBC's "Masterpiece Theatre," including the third series of "Upstairs, Downstairs" and Dorothy Sayers' "The Unpleasantness at the Bellona Club." Since last September, some children's programs have been captioned, including the "Once Upon A Classic" series.

Most of the captioning is done by Doris Caldwell, PBS' Coordinator of Programming for the Hearing Impaired, working with one assistant. "Our average for the first year and a half was about 15 hours to caption a 30 minute show," she says—considerably better than Howe's two weeks. "Since then it's gone down drastically. It now takes about 10 hours for a 30 minute show."

Caldwell chooses the programs that will be captioned. "What I've tried to do as the advance programs come in is to pick the real blockbuster programs ahead of time," Caldwell says.

PBS deliberately restricts the amount of captioning at present, according to Caldwell, because there are too few decoders to make closed captioning really worthwhile. For this reason, captions that are sent out closed are also sent out at least once as "open" captions—part of the regular video signal. PBS tries to avoid too much open captioning so as not to jeopardize long-range project goals: mass production of decoders for home use and routine

turn page

Top. Captioning for the Public Broadcasting Service is done by Doris Caldwell. Working with a captioning "script" and a precise clock, Caldwell codes the times that each caption will appear into a computer memory that has already recorded the words. Bottom. Closed captioning is a popular cause with deaf NBS employees. Chemist Simon Carmel (right) signs his opinion that "People don't object to subtitles on foreign films, and if we can't have closed captioning, I would like to see hearing people accept the idea of open captioning on TV at any time." NBS photographer Mark Helfer acts as interpreter.

addition of closed captions by programmers on all networks.

Whether the commercial networks will adopt closed captioning is problematic since the three major networks opposed the petition before the FCC, arguing that more work needed to be done.

In addition to some technical objections raised to the design of the captioning system (see box), one or more of the networks argued before the FCC that the number of people who needed and would use the system was too small to make the effort worthwhile; that the number of shows that could be captioned was also too small (present technology only applies to shows on video tape); that the decoders would cost more than PBS estimates and be an unnecessary financial budren on the handicapped; that other systems are in development and it would be wrong to lock industry and users into one particular system before the others are tried; and that reserving an entire line of the vertical interval for this use alone, as PBS requested, would be wasteful.

The last objection, at least, has been answered by the FCC decision, which indicated that line 21 (the captioning line) could also be used to transmit other information, such as news, weather reports, and—the original NBS intent—time. A major manufacturer has already visited the Time and Frequency Division to discuss the development of an integrated circuit chip for captions and time-of-day.

And cost may not be a problem for the handicapped, according to Dr. Malcolm Norwood, Chief of HEW's Captioned Films and Telecommunications Branch, which sponsored the PBS project. "We've been working on this for the last 3 to 4 years. Now, after the FCC decision, we are considering putting into gear different plans, different options. One of these is possibly subsidizing at least some of the decoders. My office is exploring ways and means of making the decoders available to anyone whose hearing is impaired and who wants one," said Norwood.

Norwood said that his office is also working on two other problems: encouraging networks to adopt captioning systems and planning seminars and training sessions to teach people to do the captioning. A good captioner must be able to time the captions right, be able to condense wordy dialogue without losing the sense of the exchange, write at the proper language level, and do it all efficiently.

In the final analysis, the human benefits from closed captioning may be well worth the costs. Among those who suffer the isolation of deafness

How "Closed Captioning" Works

The television picture you see is a series of still pictures that combine, like a movie, to give the illusion of motion. Each picture in turn is made up of 525 interlacing lines which are transmitted and displayed on the screen one at a time to build up the complete picture. Thirty times a second a beam of electrons scans the face of the picture tube, going across each line once. There is a short period between successive pictures called the "vertical blanking interval" which is made up of 21 lines and corresponds to the horizontal black bar seen on the screen when the picture "rolls" out of adjustment.

Information for the picture caption is transmitted on—in this case—line 21 of this interval along with the regular picture. If the picture were to roll, the code would be visible as a series of dashes towards the bottom of the normally unseen black bar. They are "read" by the decoder and displayed on the screen. Currently, these captions can appear anywhere on the lower third of the screen, either on the right side or the left, which allows the captioner to give a rough indication, by where the caption appears, of who is speaking. The positioning information is also sent in code on line 21.

Some technical considerations at issue in closed captioning include data rate, multiple addressing of data, and adaptive equalization.

Data rate is the amount of data that can be transmitted within a specified time. This rate is determined by bandwidth—the frequency range over which information is sent. The broader the frequency spectrum (and the higher the possible data rate), the greater possibility that noise will interfere with information. By decreasing the bandwidth, the signal-to-noise ratio is increased and decoding of data is substantially more accurate. The technical challenge is to find the optimum data rate, one that allows sufficient speed of transmission without noise interference.

Multiple addressing is the sending of different types of captions within the same bandwidth. It requires a relatively high data rate. With such a system, decoders could selectively read data at a certain "address" allowing, for example, the same show to be seen simultaneously on one set with English captions, on another with Spanish captions, and perhaps with weather or time and frequency information on a third. The decision on whether multiple addressing should be used has not yet been made.

Adaptive equalization eliminates the effects of "ghosts" or double images that can cause the caption decoder to make errors. The PBS system proposes using adaptive equalization, but some critics argue that the technique is not sufficiently developed and has not been sufficiently tested.

Another issue yet to be resolved is how well captioning will fit into regular TV programming. The present techniques and hardware have been designed for shows that are video taped, but a substantial amount of programming is either "live" or on film, mediums for which captioning technology is not yet well developed. According to HEW's Malcolm Norwood, the Captioned Films and Telecommunications Branch will probably fund more research in these two areas.

and hearing loss, there is little doubt of this. Norwood speaks for many when he says, "I myself, as a totally deaf person, see this as a landmark. I see it as a way to help bring us into the mainstream of society. It will, I believe, have a tremendous effect on the young deaf child in particular. TV as we have known it has been a series of pictures without any particular meaning. Now we will be able to enjoy television as other people do."

And back at NBS, deaf workers have followed the development of TvTime with interest and hope. Jack Clair of the Boulder Laboratories print shop comments happily, "The deaf people will now be able to understand what's going on in the world."

Simon Carmel, an NBS chemist, looks beyond the use of closed captions for enjoyment and education to even more serious uses—such as the transmission of emergency messages. "Most deaf people have to wait until the next day or two days to get emergency news," he says. Carmel himself drove into Washington, D.C. during the 1968 riots, only to be stopped by the military, because he hadn't received the news that everyone else had heard.

"I'm very happy with the people at PBS who understand our problem," he says, "I feel the closed caption system is very helpful. □

OUT OF THE CLASSROOM INTO THE LABORATORY

Jo Trueschler prepares samples for adsorption studies of aminobenzoic acids.

by Madeleine Jacobs and Esther Solomon

MOST college students look forward to January to relax and take a break between semesters. But 14 honor students from the College of Notre Dame in Baltimore, Maryland, used their semester break this year to participate in a unique four-week science training program at the National Bureau of Standards (NBS) in Gaithersburg, Maryland.

The group of predental and premedical students worked in the NBS Institute for Materials Research (IMR) on projects related to medical, dental, and clinical chemistry research. The program was initiated through the efforts of Dr. George Mattamal, who is both a visiting professor at Notre Dame, primarily a school for women, and a Research Associate of the American Dental Association (ADA) Health Foundation Research Unit at NBS where he conducts research on bone and tooth mineral. The overall program was under the direction of IMR Deputy Director Dr. Emanuel Horowitz, Mattamal, and IMR Executive Officer Ronald Johnson and involved nearly 20 NBS scientists and ADA Research Associates.

Mattamal calls his group of students "highly motivated and highly intelligent women who need a little bit of encouragement." Mattamal believes there is a need for more women in science and that this program will help toward that end. He notes that of five students he brought to the Bureau in 1972 in a similar program, two have earned Ph.D.'s and another is in medical school. He is hopeful that the program with the College of Notre Dame will become permanent, as a means of furthering NBS' interest in developing a future generation of scientists, dentists, physicians, and engineers.

"The Bureau benefited from the program because it brought in people who had knowledge of the particular fields to which they were assigned and could apply their knowledge to current research problems," explains IMR Deputy Director Horowitz. "In addition, the program exposed young people to the work climate in the area they will be entering. I believe each one of these students learned that when she gets into a research laboratory, she has to use her own creativity. There's no 'cookbook' to help out like there is in a college laboratory. The accumulated knowledge gained in college pays off at that time."

May Elizabeth Miller, a 21-year-old premedical/chemistry major couldn't agree more. "I found a major difference between working in a scientific laboratory and a school laboratory," she says. "You really have to know what you're doing and think out carefully what different ideas you will try. There's

Jacobs and Solomon are writers in the NBS Office of Information Activities.

HONOR STUDENTS WORK AND LEARN IN A UNIQUE SCIENCE TRAINING PROGRAM AT NBS

no one around, like at school, to tell you what to do." Miller worked with Dr. Warren Grant of the Polymers Division studying the purity of blood proteins involved in heart implant research.

"I think it's a completely different picture than in college," adds Claire Skarda, a 19-year-old premedical student who spent her four weeks working on bone and tooth material with Dr. Taki Negas of the Inorganic Materials Division. "I think I really began to appreciate what it is to be a chemist," she says. "During our month, we got a chance to talk to people who have been in the field a long time. It gave us a new and realistic viewpoint of what it means to do research."

Skarda, working with fellow student Michele Austin, a predental/chemistry major, completed the synthesis of a new compound during her month at NBS. The compound, a variation of the mineral in tooth enamel, will aid in studies of tooth decay.

Another predental chemistry student, 20-year-old Robin Eden, worked on research she had begun at the National Institutes of Health last summer. Her project involved the biopsy of rats' teeth which had received an experimental fluoride treatment. She worked with Dr. Lawrence Chow, an ADA Research Associate. The research is aimed at finding ways of

Students participating in National Bureau of Standards—College of Notre Dame Science Training Program

*Michele Austin, 19, Washington, D.C., predental/chemistry major. Worked with Dr. Leroy Schroeder and Dr. Taki Negas on "High temperature preparations of substituted fluoroapatite, the bone and tooth mineral."

*Kathleen Carine, 22, Bethlehem, Pennsylvania, premedical/chemistry major. Worked with Dr. Evelyn Rockar on "Wear of polycrystalline alumina in a simulated physiological environment."

*Mary Coyne, 24, Baltimore, Maryland, predental/chemistry major. Worked with Dr. Nelson Rupp on "Composite restorative resins: relationship between composition and volumetric shrinkage."

*Dianne Dulik, 19, Randallstown, Maryland, premedical/chemistry major. Worked with Dr. Gerhard Brauer and Dominic Termini on "Synthesis and study of the effectiveness of methyl p-dimethylphenyl acetate as polymerization accelerator for dental resins."

*Robin Eden, 20, Potomac, Maryland, predental/chemistry major. Worked with Dr. Lawrence Chow on "*In vivo* fluoride uptake of rat teeth from topical treatments with intermediate formation of $CAHPO_4 \cdot 2H_2O$."

*Cynthia Grams, 19, Brunswick, Maryland, premedical/biology major. Worked with Dr. Joseph Antonucci on "Ambient polymerization of methacrylate monomers using organic peroxyesters and ascorbic acid: A potential new initiating system for dental monomers."

Kathleen McManimon, 22, Trenton, New Jersey, predental major. Worked with Dr. Anthony Bur on "Piezoelectric measurement of bone."

*May Elizabeth Miller, 21, Baltimore, Maryland, premedical/chemistry major. Worked with Dr. Warren Grant on "An investigation of protein purity by electrophoresis."

*Enid Doria Porrata, 19, Santurce, Puerto Rico, predental/chemistry major. Worked with Dr. Rafael Bowen and Craig Olson on "Improving composites with the help of thermal gravimetric analysis, differential thermal analysis and mass spectroscopy."

*Maryam Sadjadi, 22, Lutherville, Maryland, premedical/chemistry major. Worked with Dr. Edward Prosen on "Calorimetric measurements of glycerol in blood serum."

*Claire Skarda, 19, Towson, Maryland, premedical major. Worked with Dr. Leroy Schroeder and Dr. Taki Negas on "High temperature preparations of substituted fluoroapatite, the bone and tooth mineral."

*Karen Speck, 21, Baltimore, Maryland, premedical/chemistry major. Worked with Dr. Anna Fraker on "Corrosion of metal implants."

*Jo Trueschler, 21, Bel Air, Maryland, predental major. Worked with Dr. D. N. Misra on "Chemisorption on hydroxyapatite: Survey of certain chelating groups."

Jeanne Waterman, 18, Queenstown, Maryland, premedical/chemistry major. Worked with Dr. George Eden and Dr. Joseph Powell on "Dental castings and surface profile measurements."

* Presented papers at American Chemical Society Student Affiliate Meeting in March 1977.

turn page

improving topical fluoridation, a means of preventing tooth decay. Eden says she enjoyed the experience because, "when you're in school you don't see what working in science is really like. At NBS, we saw the theories we learned in college put to use."

One student whose experience at NBS was closely tied to her career goals is Mary Coyne, a 24-year-old certified dental assistant and a predental student who will probably be attending the University of Maryland Dental School in the fall. Coyne worked with Dr. Nelson Rupp, an ADA Research Associate, on composite resin specimens used as dental restoratives. "I understand so much more about the properties of dental materials," explains Coyne, "and how much more needs to be learned through research." She believes this understanding will be helpful to her as a dentist.

The research experiences for the students gave them a clearer idea of what will be expected of them as chemists, researchers, physicians, and dentists. Kathleen Carine, a 22-year-old premedical/chemistry student who worked on ceramic implants with Dr. Evelyn Rockar of the Inorganic Materials Division, noted that laboratory research "helps you find out where you can improvise and where you can't, where accuracy counts and where it is not that important." Carine is president of the chemistry club at school.

The importance of accuracy also made an impression on Kathleen McManimon, 22, a predental student who worked on a Standard Reference Material (SRM) for polyethylene used in implant studies with Dr. Anthony Bur of the Polymers Division. "Before I came to the Bureau," relates McManimon, "I pictured NBS as an organization that was involved only in weights and measures. I never realized the scope of its work or how accurate it had to be. Working with materials for the SRM's, I had to be extremely meticulous so I wouldn't contaminate the samples. Now I realize how important and difficult it is to develop an SRM."

The students were given a great deal of responsibility and minimal supervision during the month-long program. Dr. Ray Bowen, Associate Director of the ADA Health Foundation Research Unit at NBS and a pioneer in research on composite resins, was especially impressed with the abilities of the students and the fact that they were working on their own time and expense. Moreover, many of the students commuted more than 100 miles daily between the Bureau and their dormitories in Baltimore.

NBS chemist Dr. Joseph Antonucci of the Polymers Division adds, "The students made an impressive contribution to NBS work in the short time they were here. We've had summer students before, but these women needed a lot less supervision." All the NBS scientists and engineers are looking forward to the possibility that many of the students will return to NBS this summer.

"I liked the way that we were treated as adults," says 19-year-old Cynthia Grams, a premedical/biology student who worked on a new dental polymerization accelerator with Antonucci. "It's like a stepping stone," she continues. "We had some responsibility, but could always turn to our supervisor and discuss a point if we had to."

Nineteen-year-old Dianne Dulik, a premedical student who worked on the determination of bond strength of adhesives with NBS chemist Dr. Gerhard M. Brauer, comments: "The thing that impressed me the most was when Dr. Brauer explained things, it was always 'we'. I didn't feel like an observer. I felt like an active participant in what was going on. Observing is important, but experience is a lot more valuable and that's what I got here—experience."

Left to right. Claire Skarda and Michele Austin work with Dr. Robert Roth and Dr. Taki Negas on the synthesis of a substituted lead-bearing hydroxyapatite.

May Elizabeth Miller demonstrates electrophoresis of blood proteins to Maryam Sadjadi (left) and Dr. Warren Grant.

Robin Eden (left) and Dianne Dulik demonstrate to Dr. George Mattamal how to set up equipment used in studying fluoride treatment in rat teeth.

Twelve of the fourteen students presented reports of their research at the American Chemical Society Student Affiliate meeting at Morgan State University in Baltimore in March.

Not all the students had the same type of experience, however. Jeanne Waterman, who at 18 was the youngest premedical/chemistry student, was assigned a project that involved studies of the surface of an alloy to replace gold crowns in dental restorations. Shortly after she arrived, the machine used to make measurements for the studies broke down. Taking it in stride, Waterman spent the remainder of her time visiting other laboratories and learning what her fellow students and scientists were doing.

This experience underscored for all the women that research is never easy or predictable. Says McManimon, "Sometimes it was really frustrating, and I'd have to repeat experiments or stop and go to the library and look things up. But now I have a better understanding of what science is all about."□

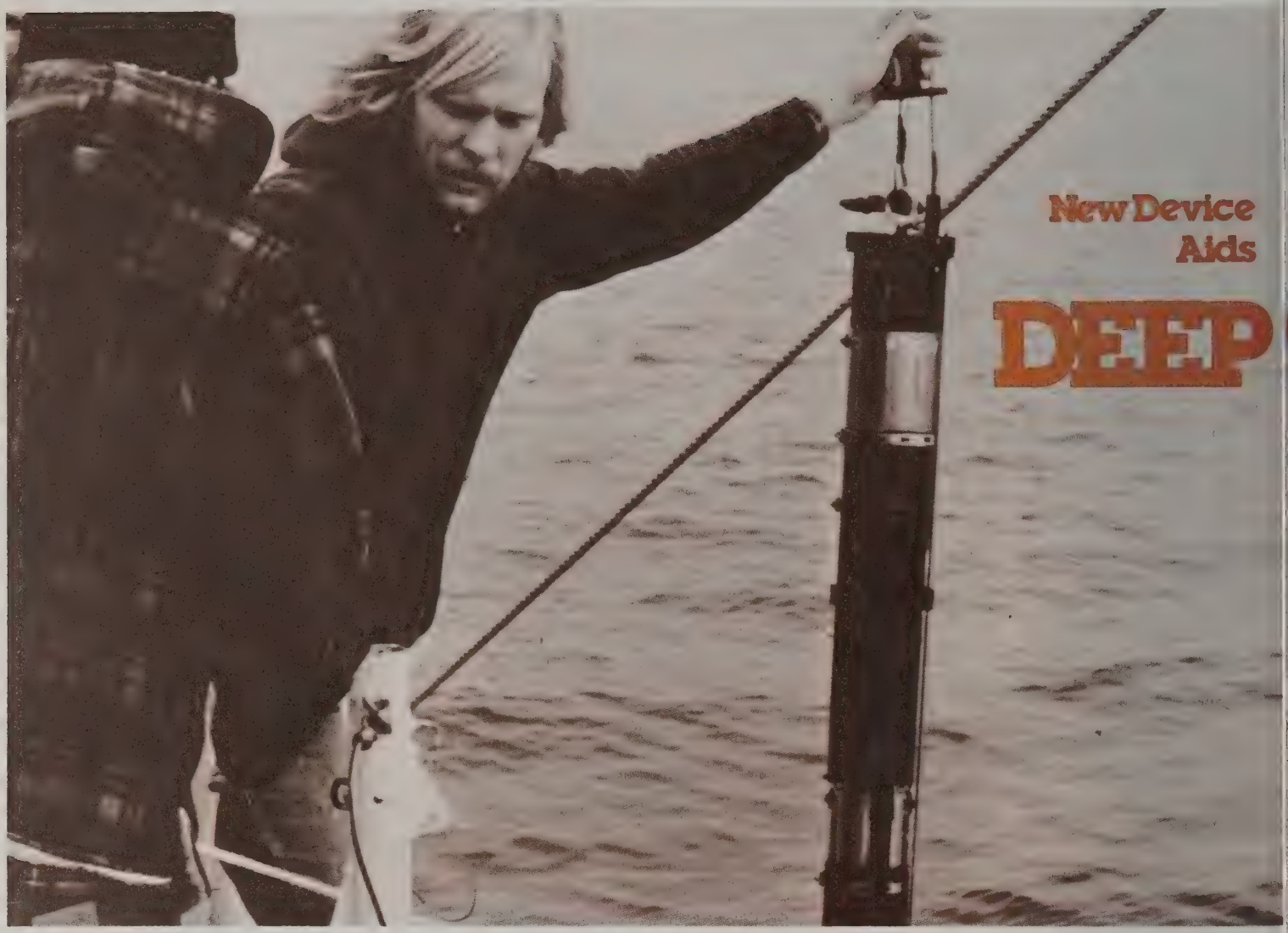
HEALTH-RELATED RESEARCH AT NBS

Through its Synthetic Implant Program, the National Bureau of Standards is working with manufacturers, government agencies, standards organizations, and physicians, to assist in the development of needed standards, specifications, and test methods for materials surgically implanted in the body. The goal of the program is to develop the broad measurement methods and characterization procedures and data base on which implants can be selected for a specific application in the body.

The NBS program focuses on polymer and metallic implant materials used in the two largest fields of surgery—the orthopedic and cardiovascular areas. The needs and problems of ceramic implant materials also are being studied.

The Dental Research Program at NBS is carried on in cooperation with the American Dental Association (ADA), the National Institute for Dental Research, and the Armed Forces Dental Corps. The NBS-ADA program, begun in 1928, focuses on the development of improved dental restorative materials, equipment, and preventive dentistry techniques. A fully equipped dental clinic on the NBS grounds at Gaithersburg, Maryland, makes it possible to correlate many laboratory findings with clinical practice. The program is under the leadership of Dr. James Cassel, Chief of the Dental and Medical Materials Section in the NBS Institute for Materials Research and Dr. Walter Brown, director of the ADA Health Foundation Research Unit.

The ultimate goal of the clinical chemistry program at NBS is to improve the health care delivered to the patient through improved accuracy of clinical chemistry measurements. NBS develops and provides selected Standard Reference Materials (SRM's) for clinical chemistry applications. SRM's are well characterized materials produced and certified for purity, composition, and/or physical properties. More than 40 SRM's for clinical chemistry applications are available from the NBS Office of Standard Reference Materials. In addition, NBS is working with some of the nation's best clinical laboratories to establish the accuracy of reference methods for clinical chemistry by developing clinical reference methods. Reference methods are methods of known and proven accuracy that can be used to determine the error in methods in common use.



New Device Aids DEEP

by Madeleine Jacobs

"The ocean is forgiving; it is huge and self cleansing. It absorbs the indignities inflicted upon it by mankind and thus far anyway, nothing drastic has happened as a result. But there is concern for the future."

from "The Ocean: A Waste Dump"
The Washington Post
December 28, 1976

EVERY year, millions of metric tons of oil and other materials end up in the world's oceans. Most of the oil is a result of relatively minor spills from tankers transporting petroleum around the world. Frequently, however, major disasters add substantially to the sum of materials foreign to the marine environment. For example, last December, in what is regarded as the nation's worst spill, a tanker broke up off the coast of Nantucket Island, leaking its entire cargo of 180,000 barrels of thick industrial fuel oil into the Atlantic. Although most of the oil drifted out to sea, some settled on the ocean floor near the Georges Bank, a valuable fishing area and the breeding ground for many fish and other marine life in the vicinity of Nantucket

Jacobs is a writer and public information specialist in the NBS Office of Information Activities.

In the laboratory at the University of Maryland, Dr. Max Klein, a physicist from NBS, and Dr. Rita Colwell, a microbiologist from the University of Maryland, look at colonies of deep ocean microorganisms cultured from water samples retrieved by the sampling device (on the counter).

OCEAN RESEARCH

Island. The full extent of the damage to the area's marine ecology is still unknown and may not be known for many years. In addition to oil spills, deep ocean dumping of sewage and other domestic and industrial wastes and offshore oil and gas exploration contribute foreign matter to the sea.

The question is, what becomes of all these substances? Many marine biologists are interested in answering this question and some have focused their attention on microorganisms living thousands of meters beneath the ocean's surface. At these great depths, the pressures are extremely high and the temperatures are near freezing. Researchers are trying to learn whether microorganisms decompose waste and other materials under these extreme conditions and, if so, how rapidly the decomposition occurs. The answers could be crucial: There may be a limit to how forgiving the oceans are, and if deep sea microorganisms do not decompose organic and inorganic wastes, or do so very slowly, the oceans could eventually become overloaded with foreign materials that could affect their productivity and, ultimately, human activities.

The main problem in this kind of basic research is the retrieval of marine life from the ocean depths so that it can be studied in the laboratory under the same kinds of conditions as those found on the ocean floor. Maintaining the high pressures and low ocean temperatures encountered during and after the sampling has proved to be an unusually difficult task. In particular, the change in pressure that normally occurs during retrieval by conventional water sampling techniques has limited the study of pressure-loving organisms in the deep ocean.

Now a unique device developed at the National Bureau of Standards is helping researchers probe the ocean depths in search of microorganisms that may play a crucial role in marine ecology. The new instrument is an aseptic deep ocean sampler. With this device, water samples may be retrieved at the deepest ocean depths encountered in the world—up to 9600 meters—while essentially maintaining the retrieved samples at the pressures corresponding to those depths. At 9600 meters, the pressure is about 1000 times normal atmospheric pressure, or 102 megapascals.

The sampler was designed and built by physicists Harry A. Davis, Meyer Waxman, and Dr. Max Klein of the Heat Division in the NBS Institute for Basic Standards in collaboration with University of Maryland microbiologists. It has been used successfully to retrieve marine life from depths of 6800 meters and 3500 meters by the NBS scientists and by microbiologists Dr. Rita Colwell and Paul S. Tabor of the University of Maryland (UM). The research was funded by a grant from the National Science Foundation to the University of Maryland and by NBS.

NBS' Davis explains some of the key features of the new sampler. "The sampler is relatively inexpensive, small, corrosion-resistant, and safe to operate. It is rugged and reliable enough to be used in any deep ocean biological sampling, even from aboard a vessel having relatively primitive equipment." Davis adds that the 36-kg device can be operated from a ship's cable or from a free fall vehicle and relies only on mechanical spring power for operation.

"Previous devices for sampling deep ocean bacteria have been limited in these capabilities," Davis says. "Some of the other sampling devices have been costly and cumbersome to use, which has restricted research to those laboratories with extensive resources. The new sampler overcomes these problems."

NBS co-worker Waxman points out that "the development should mean a major step forward in the measurement state-of-the-art in deep ocean microbiology. It should open up the field to small research laboratories that might not otherwise have the resources to engage in this type of exacting research."

In developing the device, the NBS team designed it so that the sampling chamber functions as an "incubator" in which any organisms in the sample can be cultured and experiments carried out on their metabolic activities in the laboratory after retrieval. Samples can be periodically removed for study from

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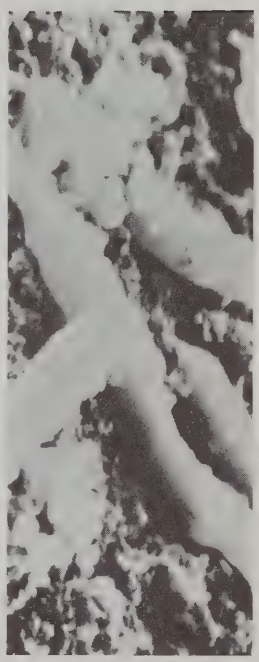


This is a photograph taken with a scanning electron microscope of deep ocean bacteria retrieved from a depth of 3500 meters and cultured in a laboratory at the University of Maryland.

COVER STORY

Schematic Diagram of Sampling Events and Sample Handling:

1. Sterilized chamber and liquid contents are pressurized to desired in situ *pressure and sampler deployed.*

2. Valves open the chamber at equivalent deep sea pressure, pump flushes the chamber and draws sample, and

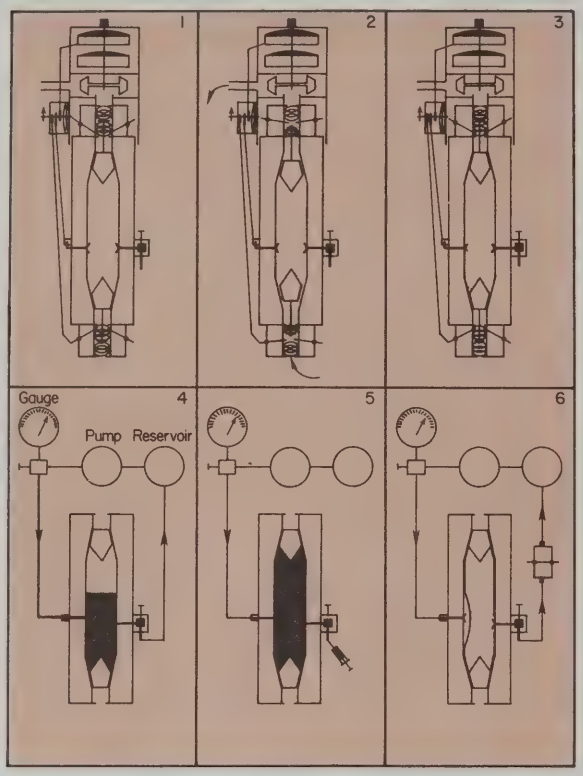
3. Valves spring closed, trapping sample. Pressure inside chamber is retained on return to surface.

4. A closed, pressurized system introduces labeled substrate into sample chamber via pre-loaded capillary tubing. The sample is incubated with continual mixing.

5. Bleeding subsamples for microscopy and metabolic analysis require replacement with sterile artificial seawater to maintain pressure in the chamber.

6. Improvements now in progress are: chamber liner to prevent contamination and dilution on subsampling; a transfer system to permit withdrawal of undecompressed subsamples.

University of Maryland microbiologist Paul Tabor is shown with the deep ocean sampler in the laboratory at UM. He is making an adjustment to the device.



the chamber without altering the chamber pressure and without decompression of these subsamples.

The sampler had been thoroughly tested in laboratories at NBS and at the National Oceanic and Atmospheric Administration before an expedition was made early last year to the Puerto Rico Trench. Located off the northeast coast of Puerto Rico, the trench is the deepest part of the Atlantic Ocean. On this trip, the NBS and UM scientists collected water samples from 6800 meters and 3500 meters and maintained the pressures after retrieval at 70.3 megapascals (about 694 atmospheres) and 35.5 megapascals (about 357 atmospheres), respectively. The temperature was maintained at 3°C.

On return from the trip, Colwell and Tabor in their laboratories at the University of Maryland carried out studies on the sample from 3500 meters. They introduced minute quantities of nutrients into the sampler-incubator, and over a period of months they have monitored the growth of the bacteria by periodically removing material from the chamber. With a scanning electron microscope, they have observed bacteria under high magnification that appear to be similar to other deep ocean bacteria that the Maryland scientists have examined from water and sediment collected by routine methods.

There are also some new findings. "We are able to see more bacteria under the scanning electron microscope than we are able to culture," Colwell states. "This leads us to believe that some of these organisms may be new species that, in order to grow, require pressure, nutrients, or other conditions that we have not yet determined. We have also observed unusual structures on the surface of some of the bacteria that may possibly play a role in the ecology of the microorganisms."

The researchers have been collecting and computerizing data on the activities of the microorganisms in order to determine the identification, classification, and distribution of the deep ocean bacteria. One of their goals is to develop a computer bank that would permit the rapid identification of deep ocean bacteria for the purpose of understanding the microbial ecology of the deep sea.

They have also been trying to answer the crucial question of what happens to foreign substances under the conditions found on the ocean floor. In one experiment, they found that the microorganisms degrade petroleum, but the process proceeds very slowly at the high pressures and low temperatures found in the deep ocean trenches.

In addition, they are studying what happens to polychlorinated biphenyls, or PCB's, when they are introduced into the culture chamber containing deep ocean bacteria. These ubiquitous and potentially toxic chemicals have been detected in the deep oceans by other researchers. The Maryland scientists also are studying how well the bacteria break down and recycle other waste products under conditions found in the ocean depths.

Even as these experiments continue, new samples are being retrieved for study. Late last month, the Maryland researchers made a trip to the Cayman Trench off Kingston, Jamaica, with the NBS sampling device. The sampler has proved to be so popular that marine biology laboratories in other countries, including France and Japan, are interested in building their own, and the NBS plans are being made available to them.

Says Colwell of the research, "Even if we don't discover any new forms of life, the new sampler has played a crucial role in providing new and useful information about the kinds and activities of the deep sea bacteria." □

The State of NBS

by Acting Director Ernest Ambler

Last month, DIMENSIONS/NBS published part I of Dr. Ambler's major 1977 address to the Bureau staff, delivered on March 3. The conclusion of that address follows.

THE National Bureau of Standards operates within a governmental environment determined, as I see it, by four major factors: Congressional policy as stated in legislation, most particularly the NBS Organic Act; the policies of the Administration; the policies and program decisions made by me as director of the Bureau with the advice of the Executive Board; and the NBS budget.

The stimulus to which all major forces in our environment are responding is some aspect of a national will to have things better. In a democracy

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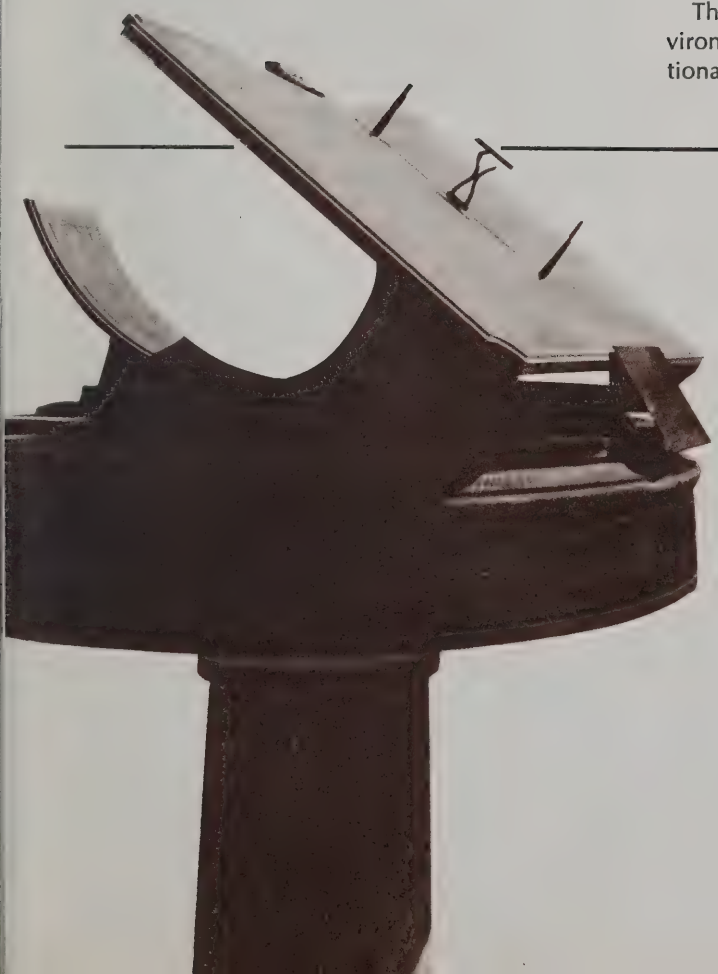


Part 2: Moving With the Times

FY 1978 Presidential Budget

	$ MILLIONS
Adjusted Base, 1978	70.2
Increases	3.067
Decreases	2.901
Net Change	+ .166

THE STATE OF NBS *continued*

such as ours, perceptions of national need are not always coordinated—sometimes they are even at cross purposes. The resolution of these forces into a successful direction for NBS is the business of NBS management.

I shall first discuss the Congressional environment, for Congressional policy, through legislation, is having an increasing impact on NBS. In the past three years, we have received nine new assignments of responsibility. I cannot discuss all of these in detail, but I will mention three of them. I will also discuss pending legislation in the areas of materials conservation and voluntary standardization.

But, first I would like to comment on a state-of-mind that seems to me to prevail among some members of the staff concerning these new assignments. There is some thought that these new assignments, which deal with very immediate—some might even say mundane—topics such as the energy consumption of appliances and the recycling of materials, will change the basic nature of the Bureau. Some say that these assignments will detract from our ability to conduct scientific research. Some believe that these assignments could destroy our reputation for technical competence.

I *disagree.*

The history of this organization is filled with examples of responding to and solving problems of the very sort that Congress is asking us to undertake today. Our reputation for technical competence will be destroyed *only* if we respond in a halfhearted manner. Our ability to conduct scientific research will diminish *only* if we condition ourselves to allow this to happen.

Let me give you an example from our history.

Between 1912 and 1923, the Bureau studied the causes of railroad accidents which had occurred with high frequency in the prior decade. In cooperation with steel manufacturers, NBS began an investigation of the constituents of railroad iron and steel, heat stress and heat treatment, and other problems in the manufacturing process. In the end, the number of railroad accidents due to steel failure was cut by two-thirds.

In the same time period, shortages of manganese led NBS to investigate whether prevailing steel-making practices could be changed so as to use less of this imported metal. Those NBS responses to very immediate, very applied national problems were the beginning of what is today our Metallurgy Division.

Responses by NBS to similar national problems resulted in the creation of the Heat Division, the Polymers Division, the Electronic Technology Division and others. I would even argue that national interest in space had a good deal to do with the formation of the Joint Institute for Laboratory Astrophysics (JILA). In 1977, I see the Alaska Pipeline study* providing a similar stimulus to our nondestructive evaluation program.

Another area of national need is that expressed in the Brooks Act of 1965 and the Privacy Act of 1974. The Institute for Computer Sciences and Technology organized well to respond to the need for Automatic Data Processing (ADP) standards. They have succeeded in gaining substantial leverage for their own limited resources by working effectively with the rest of the federal government and the Congress.

In the areas of noise abatement and radiation control, we have made some important contributions. But we have yet to develop coordinated, comprehensive programs. My point is that many of these new assignments can and must be viewed as opportunities for NBS to grow in scientific and technical competence while contributing to the well-being of the nation.

Returning to the issue of current Congressional policy, let me discuss our most recent assignments.

The Energy Policy and Conservation Act of 1975 and the Energy Conservation and Protection Act of 1976 give NBS the opportunity to provide the technical basis for energy conservation standards for buildings and appliances in the United States. Commercial and residential buildings and appliances represent over one-third of the total U.S. energy consumption. NBS can and will assure that the conserva-

* See *State of the Bureau, Part I,* March 1977 DIMENSIONS/NBS.

FY 1978 Presidential Budget

INCREASES

Equipment Depreciation	$ 163,000
Capital Expansion for Inflation	432,000
Safety Modification, Bldg. 225	1,422,000
Nondestructive Evaluation	300,000
National Voluntary Laboratory Accreditation Program	750,000
	$3,067,000

FY 1978 Presidential Budget

DECREASES

Thermal Quantities	$ 363,000
Mechanical Quantities	958,000
Electromagnetics	480,000
Metallurgy	500,000
Polymers	300,000
Building Research	300,000
	$2,901,000

tion standards promulgated by the Department of Housing and Urban Development (HUD) for buildings and the Federal Energy Administration (FEA) for appliances are technically reasonable and feasible.

The Resource Conservation and Recovery Act of 1976 gives NBS the opportunity, working through the voluntary standards system, to provide the technical basis for National Standards for materials recycling both to conserve materials and reduce environmental pollution. We know how to convert waste materials into fuel, but to ensure its use, we must characterize the heat content, trace metal impurities, abrasives and insoluble residues.

With respect to pending legislation, I expect that NBS will be assigned significant new responsibilities to provide the technical basis for materials conservation. I regard this as an appropriate area for new NBS responsibilities and I hope that the legislation will authorize direct NBS funding.

Another area of likely legislative activity concerning NBS is voluntary standardization. Major changes in the U.S. voluntary standardization system were proposed in Senate Bill, S. 3555, introduced in the last session of Congress. We believe that a revised bill with similar objectives will be introduced and perhaps passed in the 95th Congress. This bill deals with procedures for developing product and engineering standards, the participation of both the private sector and U.S. government in international standards writing bodies, and laboratory accreditation and product certification for both domestic and international trade.

If enacted, it would have a major impact on NBS. It could result in NBS becoming the central body for recognizing United States standards and standards-making procedures. The price we would have to pay is that it would require NBS to undertake a large paperwork operation, which disturbs me. On the other hand, the possibility of having this responsibility assigned to someone else would be likely to undercut our statutory functions and weaken our mission. I am wrestling with this dilemma now and would be glad to receive any thoughts you might have on this subject.

Turning now to Administration policy and its impact on NBS strategies, I think our main concern is the lead-agency concept which has governed the actions of the Office of Management and Budget (OMB) for the past three years. The lead-agency concept states that a federal objective should be managed by a single designated mission agency no matter where the work actually takes place in the federal government.

As a result of this concept, our budget initiative for standards in safeguarding nuclear materials was denied and we were referred to the Nuclear Regulatory Commission for funding. Another casualty was the Appliance Labeling Program where we were directed to terminate our base funding and seek support from the Federal Energy Administration (FEA). Exacerbating this situation is the fact that OMB took virtually all of FEA's money for appliance labeling as well.

In an effort to address this issue, the NBS Executive Board has established an interinstitute committee to propose a lead agency policy for NBS, as well as a strategy for gaining acceptance of such a policy by OMB. I will keep you informed about the progress of this very important issue.

The development of NBS policies and strategies is an important factor in dealing with Congressional and Administration actions. We must anticipate those national problems to which we shall be called upon to respond. As a result, we have worked closely with the program managers to develop a better organized Long Range Planning and Budgeting process. We have identified the following areas of national concern where we believe Congress and the Administration will or should look to NBS for effective standards.

The areas are energy, materials, regulation, consumer information and protection, and productivity.

We discussed these Principal Programmatic Objectives (PPO's) in some depth at the Strategy Feedback Conference, which was attended by more than 100 program managers and division chiefs.

You may have noted that I said that the PPO's

turn page

"One message that I have tried to illustrate is the need for a mixture of mutually reinforcing ingredients working together in an exciting high quality program."

THE STATE OF NBS *continued*

represented areas where Congress and the Administration will or *should* look to NBS. Too often policymakers in Congress, the Administration, and industry are insensitive to the need for accurate measurements, standards, and data until after they are in trouble. Industry often seems to become involved only when long-standing services are reduced, rather than working with us to show how we can be forward looking in providing for the fairness and vitality of commerce.

The solution to this problem lies with us. We must aggressively carry the NBS Story to the Commerce Department, OMB, Congress, and industry. A principal component of this story must be the lead-agency policy I discussed earlier. But there is more that can be done, and it must be done by the individual program managers in NBS. We have the right to expect leadership from all levels of management. We must be aware of the needs of our constituencies, and our constituencies must be made aware of our services. If policymakers and industrial leaders can be made aware of the true value of NBS services, we will find that understanding reflected in legislation and in budgetary decisions.

Having covered Congressional, Administration, and Bureau policies, let me turn now to the NBS budget and our fiscal health.

The FY 1978 budget process has been a difficult one. The net program change is an increase of $166,000. I am especially pleased that we have an increase item to account for inflation in the cost of equipment, in addition to one for continuing our modernization program. I am also glad to see Nondestructive Evaluation and National Voluntary Laboratory Accreditation acknowledged by OMB as important programs.

But the total budget picture is not a positive one. We must accept $2.9 million in reductions. This reduction is a cause of considerable concern to me and I'm sure to you. I am strongly of the opinion that it is *not* in the national interest to reduce NBS resources. Furthermore, it is a reduction that was *not* accepted passively.

The original reduction contemplated by the Department of Commerce for NBS was $5.8 million. It was only by making a vigorous appeal first to the Assistant Secretary for Administration and finally to the Under Secretary that we were able to get the reduction to its current level of $2.9 million.

The areas which we finally were forced to identify for reduction in the FY 1978 budget represent in my judgment, and the judgment of the NBS Executive Board, those which could be terminated at NBS with the least adverse impact on the nation and on the scientific and technical vigor of NBS.

The process of setting priorities is complex and time consuming. Low priorities are identified during the annual program reviews. The concerned member of the Executive Board and I then meet to decide whether the program should be strengthened, redirected, or terminated. This process also involves the responsible program manager.

Having made a decision to reprogram, we must secure the approval of the Assistant Secretary for Science and Technology, the Assistant Secretary for Administration, and the Congress. At best, this process takes several months. Only after these external approvals have been secured can we begin implementation.

The Engineering Mechanics Section of the Mechanics Division is an extreme case in point. In July 1976, we decided to reprogram the resources of this activity to energy-related programs, where mechanical engineering talents were more sorely needed. It took us five months—until last December—to secure all the necessary external clearances to begin implementation. The suspense in which staff members were kept was, in my opinion, unreasonable. But I think the final outcome has been fair. We now have positions for 16 of the 19 people affected by the reprogramming. We are continuing to try to find appropriate jobs for those remaining.

Another major reprogramming action is underway in the Electromagnetics Division. This action, which was proposed by the division chief and approved by the institute director, is intended to result in a more forward-looking electromagnetics program.

In an effort to help those persons involved in the

"Let us move with the times and even ahead of them, confident that by doing so we shall contribute in a vital way to the public benefit."

Electromagnetics Division reprogramming, we have taken three steps which are above and beyond the Civil Service Commission regulations. First, we have apprised the affected staff of management plans well in advance of any formal action. Second, we have established a Bureau-wide review panel to assist in job placement of the affected personnel. This has given Boulder personnel the opportunity to find positions in Gaithersburg. Finally, Boulder has established a placement center concept to identify other federal job opportunities in the Boulder/Denver area.

In summary, reprogramming is not easy, but it is necessary. It would be irresponsible for me to say that we shall not do it. I do pledge to you, however, every possible effort to help affected staff members find new and rewarding positions. And I believe it is incumbent upon all of us to maintain morale and remain productive in our work.

From this summary of external forces, you will realize that NBS is operating in a changing environment. It is particularly important, therefore, that we be clear among ourselves about what is happening. We have a mutual responsibility to address this issue. The NBS staff must understand the vital role that it can, in fact it must, play in forming and influencing the future course of NBS. At the same time it is equally vital that my own actions be predictable and understandable by the NBS staff.

I have tried to deliver several clear messages today. (See also State of NBS Part I in last month's DIMENSIONS/NBS.)

One message that I have tried to illustrate is the need for a mixture of mutually reinforcing ingredients working together in an exciting high quality program. This includes:

- Advanced exploratory and basic research looking into new areas and seeking fundamental understanding of the science that underlies a subject;
- Applied science and state of the art engineering; and
- Delivery mechanisms that assure the maximum beneficial use of our work by the rest of society.

In the programs I described this morning, I dealt with a number of areas that are vitally important to NBS. I hope I showed how we can conduct programs that matter to the nation and base them upon effective research.

I would also like to make clear my endorsement of those researchers, who by their international reputation and intellectual stature, are so important in maintaining the vigor and reputation of NBS. Individuals who are capable of such accomplishments—and there are many at NBS whom I will not mention by name—I regard as indispensable to the Bureau mission. Any vital research organization must be permeated with a spirit of intellectual inquiry. I believe this today and I have always believed it. There is a place and need at NBS for those individuals who, by the quality of their minds and labors, work at the very cutting edge of science.

But Congress and the Administration will judge us by other standards. We shall be judged by how well we discharge our statutory responsibilities for public benefit. And the public is concerned with technology and the effects of technology as never before. Credible information on better measurements, new standards, and more reliable technical data are sorely needed. The more that scientific facts can be used to resolve the bitter debates of today, the better will be the final decisions.

And so opportunities abound. We should be thankful that we are asked to do more than we can. I have yet to see a happy person who did not have enough to do. And I suspect the same is true of organizations. Our problem is not lack of opportunity, our problem is priorities. Earlier in my talk I told you of the priorities that had emerged from our Long Range Planning. I would emphasize that these are guidelines. I expect that these will be debated by Bureau staff members in their institutes and divisions.

So let us welcome the fact that times are changing. Let us move with them and even ahead of them, confident that by doing so we shall find our work more exciting, enhance the stature and scope of the Bureau, and contribute in a vital way to the public benefit. □

NBS, ALUMINUM ASSOCIATION, AND AMERICAN ELECTROPLATERS' SOCIETY FORM PROGRAM

by Madeleine Jacobs

The National Bureau of Standards, the Aluminum Association, Inc., and the American Electroplaters' Society have established a new Research Associate Program to study chrome plating of aluminum at the NBS facilities in Gaithersburg, Maryland.

The objective of the venture is to investigate the effects of pretreatments, alloy compositions, and plating processes on the mechanisms of adhesion of chrome plating on aluminum and the corrosion resistance of the composite that is formed. One of the uses of chrome plated aluminum is for automobile bumpers to reduce weight and save gasoline.

The Research associate will work in the Metallurgy Division of the NBS Institute for Materials Research, which is currently carrying out work on electrodeposition, localized corrosion phenomena, and the electro-chemistry of corrosion, among other topics.

David Lashmore of the University of Virginia in Charlottesville has been selected as the Research Associate by the sponsors. Lashmore will receive his Ph.D. in materials science from the University of Virginia in June. He received his M.S. in physics from the Michigan Technological University in 1970 and a B.S. in engineering science and mechanics from the University of Florida in 1968.

Research Associates are trained scientists and technicians sponsored by industrial companies and trade and professional organizations to work at NBS on special projects of interest to both the sponsor and NBS. The sponsoring organization, with the advice and consent of NBS, selects its own research associates who remain the employees of the sponsor.

At the beginning of 1977, there were 20 programs at NBS involving 69 research associates. Organizations and individuals interested in more information on the NBS Research Associate Program should contact P.R. de Bruyn, Industrial Liaison Officer, National Bureau of Standards, Administration Building, Room A402, Washington, D.C. 20234, 301/921-3591.

NBS CRYOGENIC FLOW MEASUREMENT CODE APPROVED

by Douglas B. Mann and James A. Brennan

A cryogenic flow measurement code for cryogenic liquids, developed by the National Bureau of Standards Cryogenics Division and the Compressed Gas Association, Inc., has been approved by the 61st National Conference on Weights and Measures. The NBS Office of Weights and Measures provided assistance for NBS' statutory responsibility toward the states.

This 1976 code is part of the adopted amendments incorporated into the recently issued 4th edition supplement to the NBS Handbook 44. Incorporation and adoption of this code replaces the handbook's 1972 tentative cryogenic code which was patterned after a State of California, Office of Measurement Standards code.

Titled "Cryogenic Liquid-Measuring Devices," the code applies to devices used for the measurement of common cryogenic industrial gases (liquid nitrogen, argon, oxygen, hydrogen), whether such measuring devices are installed in a permanent location or mounted on a vehicle. Exceptions to the code include (liquefied natural gas) and LPG (liquefied petroleum gas) applications and devices only used to dispense a product in connection with operations in which the amount dispensed does not affect a monetary customer charge.

Impact of Handbook 44 codes are mainly at the state level. Currently, all 50 states automatically accept Handbook 44 as law. Unless a state excludes the Cryogenic Liquid-Measuring Devices Code, the newly adopted code makes it illegal to sell cryogenic liquids unless the data, codes, and practices developed by NBS are followed.

The code's normal test tolerances are directly referenced to the NBS cryogenic flow reference facility and NBS-developed transfer standard flow-meters. The code states "The maintenance tolerance on 'normal' tests shall be four percent (4%) per indicated unit on underregistration and two percent (2%) per indicated unit on overregistration. The acceptance tolerance on "normal" tests shall be two percent (2%) per indicated unit on underregistration and one percent (1%) per indicated unit on overregistration."

A total uncertainty level of less than ± 0.2 percent has been established and maintained with the NBS cryogenic reference flow facility since 1971, thus providing an order of magnitude reference for precision and accuracy over the tolerance levels expressed in the Handbook 44 code. NBS Technical Note 606 reports the totalized mass flow measurement uncertainty to be ± 0.18 percent by the NBS facility (± 0.12 percent for known sources of systematic errors and ± 0.06 percent for random error). The random error was determined as three times the standard deviation calculated from 23 applications of the calibrated masses over a three month test period.

Development of this adopted code was started in 1968 at the NBS Boulder, Colorado Laboratories. The eight-year effort obtained extensive data on the performance of volumetric and mass flow devices, both under well controlled laboratory conditions and in the field. Accomplishments include:

—an evaluation of generic classes of cryogenic flowmetering devices over a broad range of expected operating conditions.

—initial work on establishment of specifications, tolerances, and recommended practices for cryogenic flow devices used in commerce, and

—promulgation of transfer standards traceable to NBS for field certification of new cryogenic meters to be put in service or recertification of in-service meters.

Over 60 flowmeters, based on five different generic types were included in the NBS evaluation program. Transfer standard flowmeters were developed and calibrated for the certification of commercial meters in the field. These NBS transfer standard flowmeters were also used in interlaboratory comparisons which provided additional validity to the NBS flow reference facility's accuracy statement. Confidence in the facility has also been established by approximately 4000 hours of actual operation.

Mann is acting section chief of the Cryogenics Fluid Dynamics Section and Brennan is group leader of the Cryogenic Flow Measurement Facilities, Cryogenics Division, Boulder, Colorado.

STAFF REPORTS

NEW TECHNIQUE FOR DENTAL RESTORATIONS

Under a contract to the National Institute of Dental Research, NBS has proposed a new technique for improving the adhesion of dental resins to the tooth surface.

Joseph M. Antonucci, Dental and Medical Materials Division, A52 Polymers Building, 301/921-3336.

A major shortcoming of all dental resins is their inability to form strong, durable bonds to dentin. The current acid etch technic, which improves the adhesion of composite restorative and sealant resins to enamel by a micro-mechanical interlocking mechanism is ineffective and contraindicated for dentin.

An alternate mechanism for enhancing adhesion is through the use of functional monomers that can react and/or physically interact with dentin and, at the same time, copolymerize with the dental resin. We propose as a coupling agent a new type of functional monomer that is expected to react primarily with the voluminous (mainly collagenous) organic phase of dentin. It is well documented that collagen undergoes condensation reactions (e.g. aldol and Schiff base) with aldehydes under moderate conditions in an aqueous environment both *in vivo* and *in vitro*. The "natural" reactivity of collagen towards aldehydes suggested the synthesis of functional monomers having pendent aldehyde groups, for the purpose of obtaining enhanced adhesion to dentin.

By facile one-step reactions involving 2-bromoethyl methacrylate and the three isomeric hydroxybenzaldehydes, the corresponding (2-methacryloxyethoxy) benzaldehydes were synthesized. These isomeric monomers are low-melting crystalline solids, readily purified by recrystallization techniques. On proper admixture, they give liquids of moderate viscosity at room temperature. They are also compatible and copolymerizable with BIS-GMA and other methacrylate monomers. Conceivably, these monomers also might serve as complementary adhesion-promoting agents for use with surface-active monomers which adhere to the calcified component of dentin.

Figure 1—Methods of Synthesis

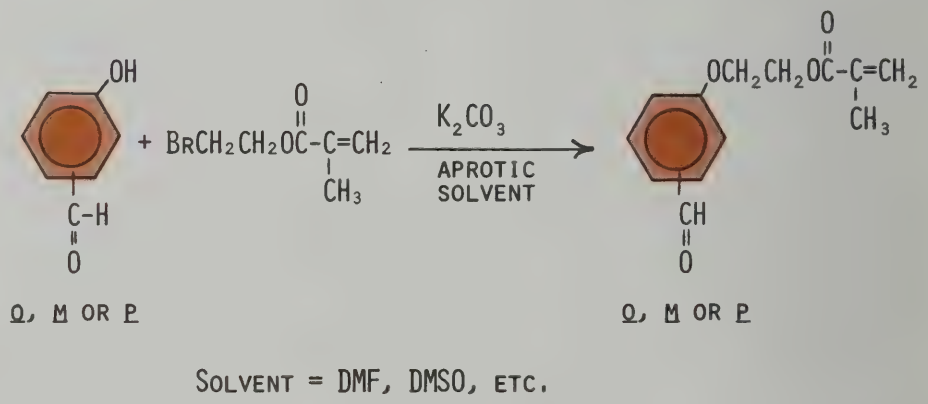
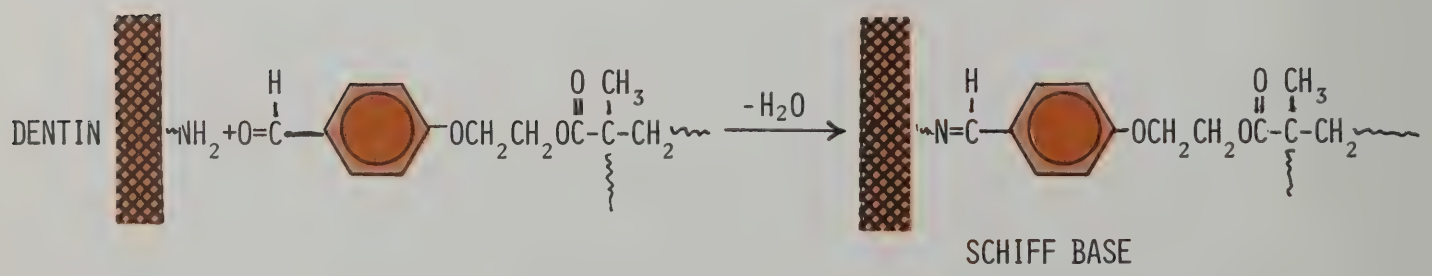


Figure 2—Theoretical Mechanism for Promoting Adhesion to Dentin



NEW CALORIMETER UNIT MEASURES HIGH LASER ENERGY

NBS has constructed, calibrated, and consigned to the Air Force's Aerospace Guidance and Metrology Center a mobile calorimeter unit for measuring the power and energy output of high-power, continuous-wave lasers. The unit handles nominal power levels of 100 kilowatts in the wavelength range from 1 to 11 micrometers. Intercomparisons with the NBS meter have led participants to revise their test procedures and thus reduce their uncertainty from as much as ±70% to ±13% for a single measurement of laser energy.

The Department of Defense presently spends about $170 million yearly on its high energy laser (HEL) programs. With the NBS calorimeter unit, DoD is now better equipped to verify contract specifications, calibrate complex and expensive devices, and measure power and energy density in research on the propagation and effects of high energy laser beams. The services of this unit is available to all DoD agencies and standards laboratories, and thus provides the armed services with calibration uniformity and the required traceability to NBS standards.

The HEL mobile unit comprises two BB-series calorimeters (NBS designations BB1 and BB2), their electronics, and computer programs for reducing data and tabulating results of intercomparisons with other power meters. A sixteen-foot trailer gives the unit its mobility.

A BB calorimeter comprises an optical cavity which absorbs light energy, a closed system circulating water through a jacket surrounding the cavity, heaters in the water jacket for electrically calibrating the calorimeter, and a resistance bridge which monitors the water temperature. Each calorimeter is enclosed in a carriage-mounted aluminum box lined with five centimeters of styrofoam for thermal insulation. The entire unit is 1.2 meters high, 1.5 meters long, 0.65 meter wide, and weighs about 400 kilograms.

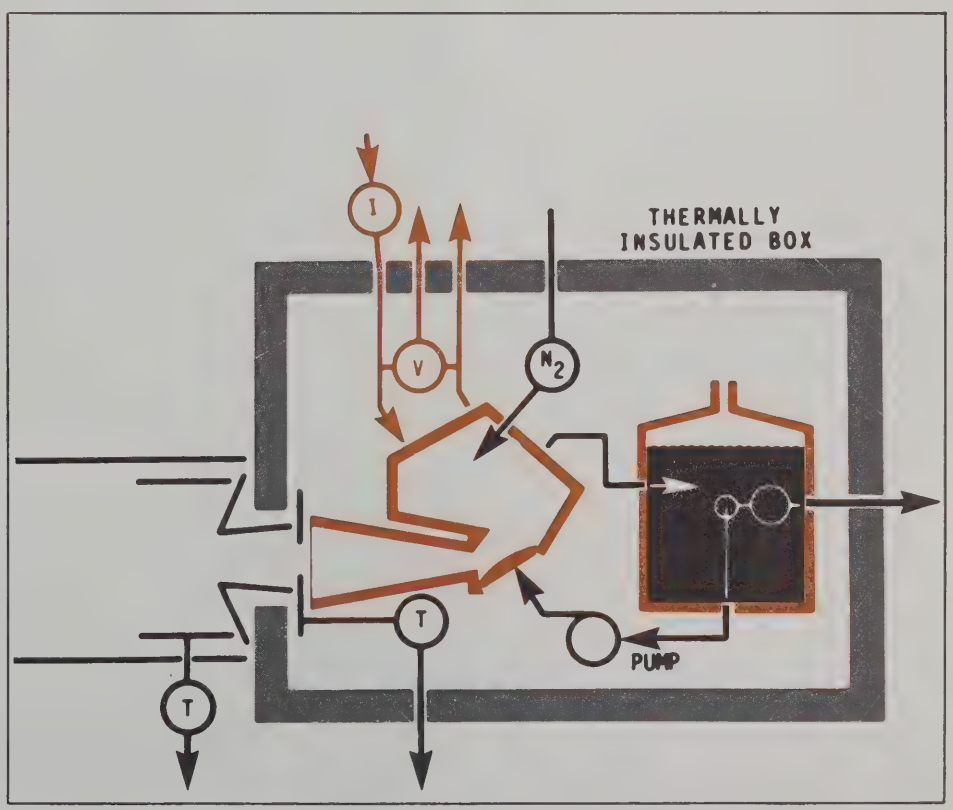
Light enters a BB calorimeter through a tapered, four-sided horn joining the optical cavity at a small entrance aperture which reduces the amount of escaping light. Mirrored, bead-blasted, and blackened surfaces then distribute and absorb the light. As the radiant energy heats the absorbing surfaces, the heat is conducted to water circulating through the cavity walls. The temperature rise of the water is a measure of the total light energy which has entered the calorimeter.

NBS calibrates the HEL calorimeters by the method of electrical substitution. Electrical standards are used to measure power generated in heaters in the water jacket. With a digital voltmeter calibrated against a standard cell, two voltage measurements are made: one across a standard resistance to determine heater current and another across the heater itself. The amount of energy delivered to the calorimeter is calculated from the heater current duration. Tabulating this energy against the change in temperature-sensor voltage furnishes the calorimeter's calibration factor in joules per volt.

turn page

Figure—Schematic

A laser beam enters the calorimeter from the left, is absorbed into the walls of the optical cavity, and raises the temperature (T) of the water reservoir. When multiplied by a calibration factor, the change in reservoir temperature gives the amount of radiant energy which entered the calorimeter. The calibration factor is obtained from the rise in reservoir temperature produced by an electrical energy input. A timed measurement of heater current (I) and voltage (V) gives the electrical energy delivered to the calorimeter. At the calorimeter entrance, temperature sensors provide over-spill and back-scatter corrections to the measurement of beam energy. Nitrogen (N_2) flowing through the cavity provides a dust-free atmosphere.



USE OF VIBRATIONAL SPECTROSCOPY FOR NDE

A flexible and powerful method of Non-Destructive Evaluation (NDE) has been demonstrated. It utilizes observation of vibrations in a plastic object after excitation by a mechanical impulse. The same approach can be applied to a wide range of objects and assemblies made of plastic and other materials.

Darrell H. Reneker, Polymers Division, A315 Polymers Building 301/921-3734

The structural soundness of an object can be evaluated if its vibrational spectrum can be compared with that of a like object of known mechanical integrity.

We have developed a method for making such observations that combines the use of piezoelectric polymer transducer, a synchronized method for mechanically exciting the test sample, and a small computer capable of making digital Fourier transforms. We initially applied this technique to a bar of polymethylmethacrylate, exciting vibrations by dropping a steel ball or striking the end-surface with a glass bob pendulum (see figure 1). Impact points were varied, and an electromagnet was used to release the ball so that time and point of contact were reproducible.

The electrical signal from the transducer was complicated, oscillatory, and decaying. It was amplified and applied to a digitizer. The digitizer was triggered by an electrical signal from the electromagnet for the vertical drops, or by the positive slope of the signal for the pendulum hits. The analog signal was filtered by a 20 kHz 4-pole Butterworth filter and then digitized at a rate corresponding to a spectral width of 20 kHz. Digital resolution was 10 Hz per point. The power spectrum of the signal in the frequency range 0 to 20 kHz was obtained using a fast Fourier transform algorithm in a computer with an 8k memory. A series of such spectra were obtained for varying modes of excitation.

These spectra were compared with those obtained from corresponding experiments conducted after the bar was altered, first to simulate mass defects and then cracks, and again after temperature-induced changes in modulus were produced.

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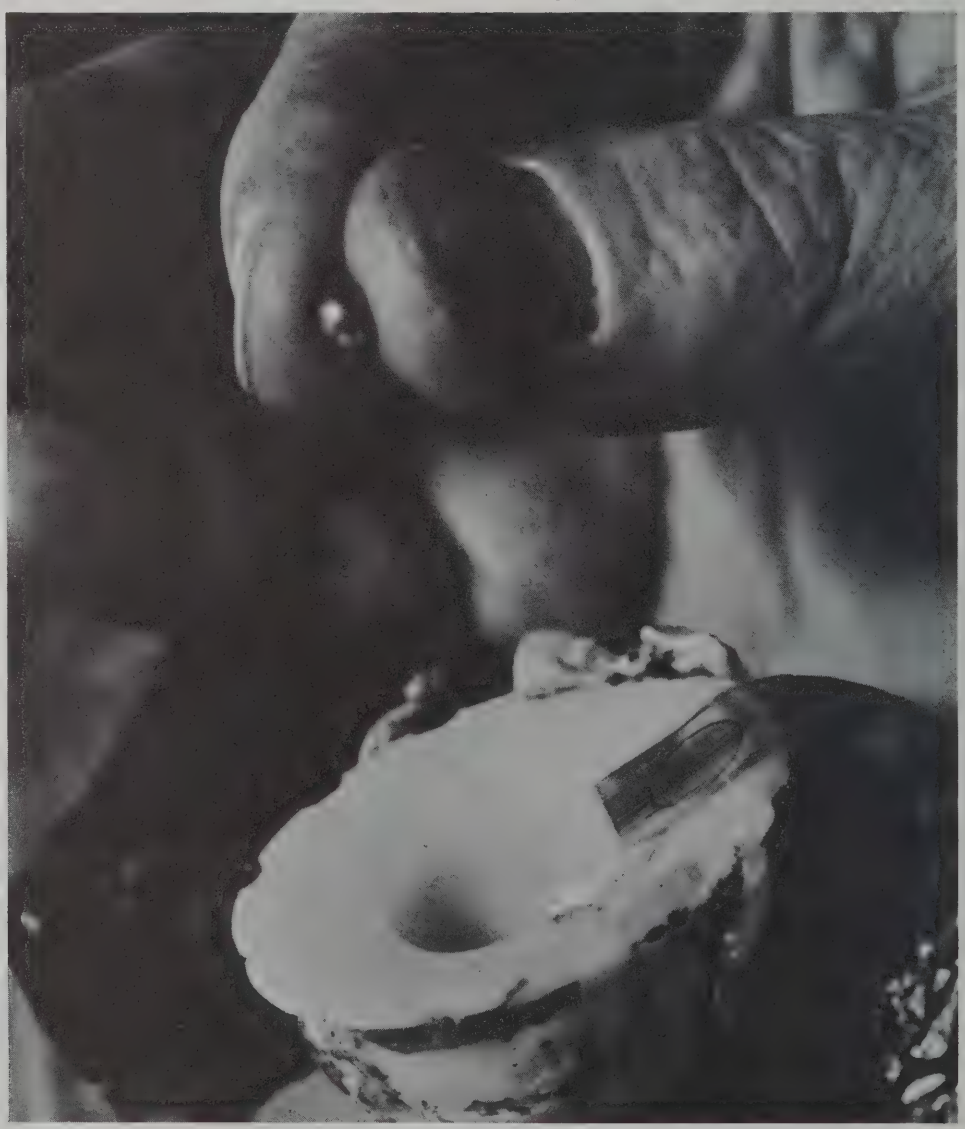
This polyethelene cup and 5-mm steel ball shown here were used in testing the effectiveness of vibrational spectroscopy as an NDE technique. A piezoelectric transducer is attached to the plastic part. A cup such as this is one of the pieces in an artificial hip joint.



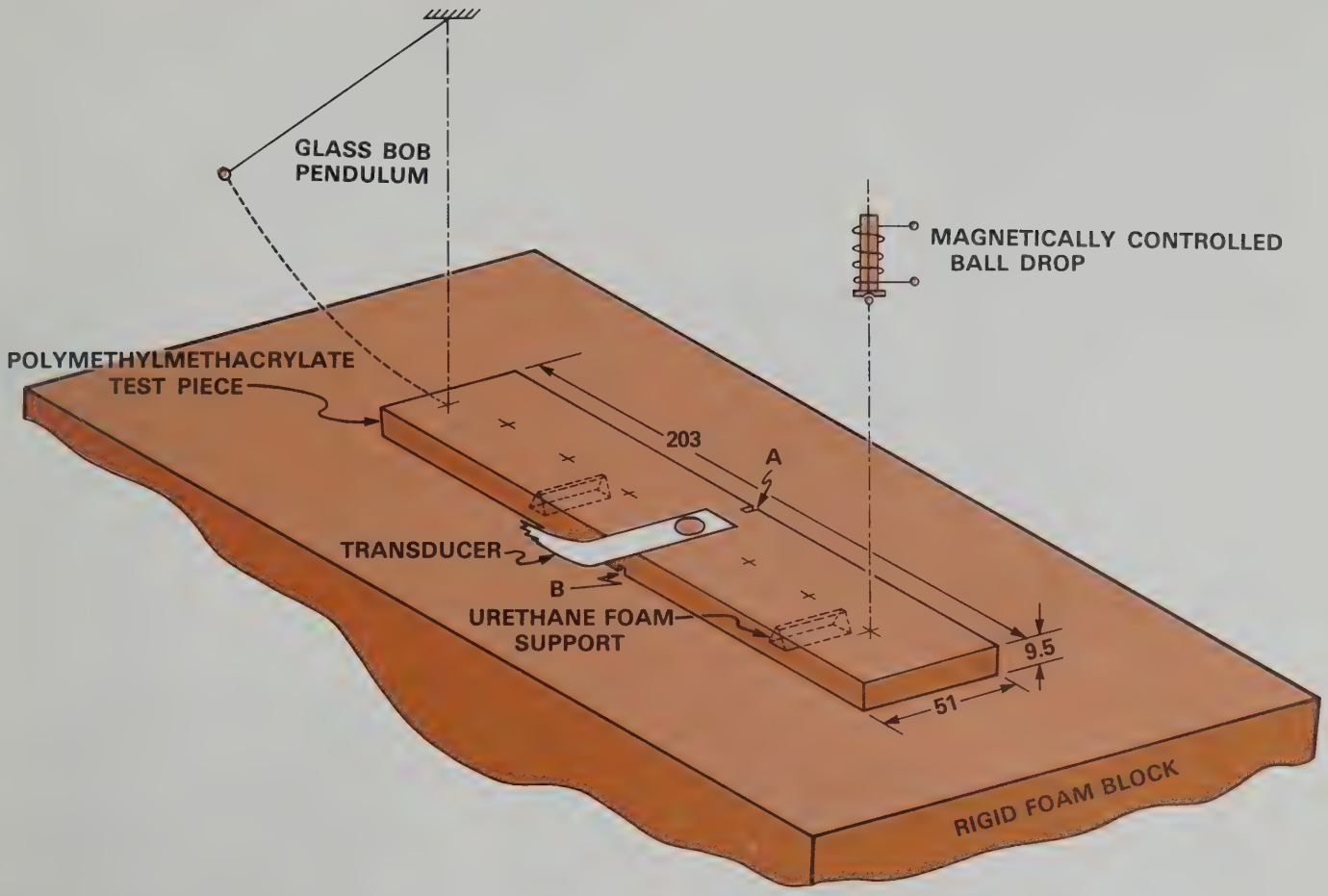


Figure 1—Sketch of Polymethylmethacrylate Test Piece. *The sketch shows methods of excitation, support positions, the point at which the transducer was attached, and the position of slots cut into the piece to simulate cracks.*

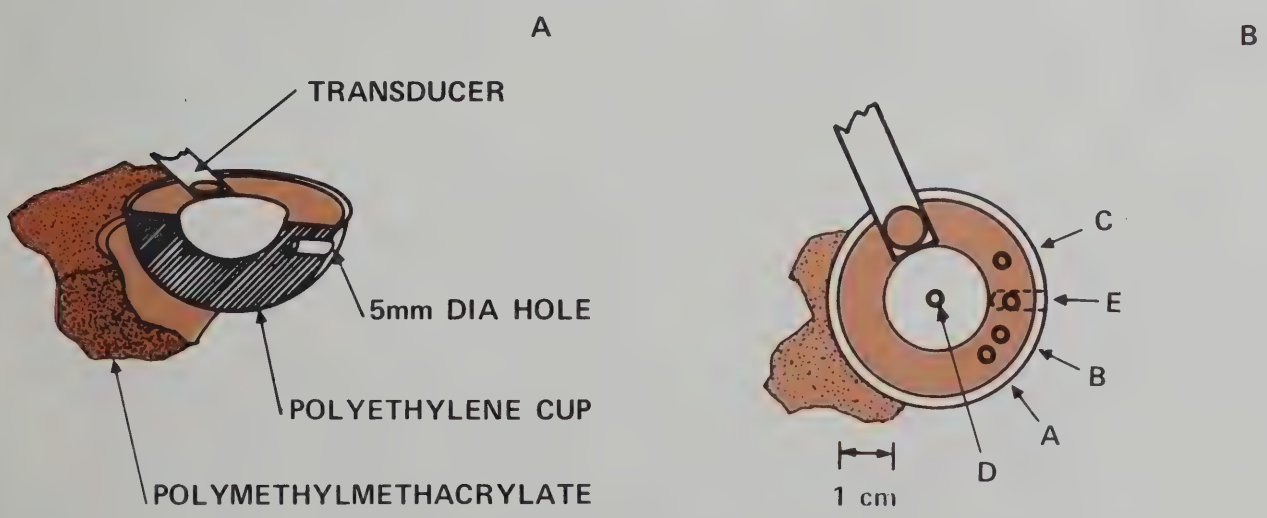


Figure 2—Two Views of Hip Implant Cup.
(a) Projection view of a section of the cup and the attached irregular piece of polymethylmethacrylate. The hole was drilled after some spectra were obtained.

(b) Top view of the cup showing the location of the transducer, the drilled hole, and the points of impact for three separate drops.

The data indicate that there are defects to which the modes observed in a particular experiment are insensitive, but in principle there exist modes of vibration sensitive to every aspect of the mechanical integrity of the sample. This method requires that the sample support, excitation, and transducer position be chosen so that the observed spectrum is in fact sensitive to the important aspects of the mechanical integrity of the part tested. This can often be achieved systematically, as we demonstrated when we tested a more complicated object, a polyethylene cup of the sort used in a total hip joint placement (see photograph).

For example, to demonstrate the effect of a defect in the cup on the vibrational spectra, a 5 mm diameter hole was drilled as shown in figure 2. When the ball was dropped onto the rim a few mm on either side of the drilled hole, the observed spectrum was similar to that observed without the hole; that is, a sharp peak with smaller adjacent peaks near 5 kHz and only small peaks in the 10 to 12 kHz range. However, when the ball was dropped onto the rim at point E (see figure 2) directly above the hole, then the peak at 5 kHz decreased in amplitude compared to the amplitude of the nearly subsidiary peaks, as well as those at 10 to 12 kHz. Thus, for a suitable excitation, the hole caused a substantial change in the distribution of energy into the various modes.

Although we have demonstrated this NDE technique on plastics, it is also applicable to metal or ceramic objects and even to assemblies of the same or different materials involving several parts in good mechanical contact. The spectra are sensitive to changes in modulus or density, both of which may vary significantly in plastics due to differences in cooling rates or additives.

Defects may cause frequency shifts, changes in amplitude of modes, or the introduction of new modes. Some defects have little effect on a particular mode, and observation of a single mode can be regarded as a test for only certain kinds of defects at certain points in the sample. Since a number of modes can be observed by varying the point of excitation (and even more by attaching additional transducers), a reasonably complete examination of the sample can be made. Higher order modes are expected to be particularly useful for detecting periodically distributed defects.

The method described here can be be used to survey and then to observe those modes of greatest interest in detail. Related vibrational NDE methods, specialized to particular objects, do not have such broad capability for survey. The fact that data are processed in digital form facilitates comparison of spectra from a test object and an object known to be good. This reduces, or in many cases eliminates, the need to identify the displacements associated with a particular peak.

NEW STANDARD REFERENCE MATERIAL TO AID RESEARCH ON ROLE OF CHROMIUM IN NUTRITION

A new Standard Reference Material (SRM) has been developed that will enable more accurate analyses of chromium, an essential trace element for human and animal nutrition. The new SRM was developed in cooperation with the Nutrition Institute of the U.S. Department of Agriculture (USDA). In a letter to researchers advising them of the development, USDA called the standard "a great accomplishment and an even greater promise for chromium research in obtaining accurate interlaboratory agreements between methods" used to determine chromium in biological samples such as serum and blood.

SRM 1569, Brewers Yeast, may be purchased for $63 per 50 gram sample from the NBS Office of Standard Reference Materials, Room B311 Chemistry Building, 301/921-2045.

Certified for its total chromium content, the SRM is intended primarily for evaluating the accuracy of chromium determinations in biological materials and for calibrating the instruments used in these analyses. The lack of such a standard has hampered research on the role of chromium in food and nutrition.

This area has received increasing attention from scientists, particularly medical researchers and nutritionists, because chromium appears to be essential for proper carbohydrate metabolism. Numerous methods are available to analyze chromium that is present in large quantities. However, its determination in biological materials such as serum and blood has been difficult and unreliable, because chromium exists in many different forms and at very low concentrations, generally parts per billion.

Chromium is analyzed using highly sensitive instrumental methods that must be calibrated by known standards. Until the NBS SRM was developed, such a standard was not available for biological materials.

The Standard Reference Material is actually brewers yeast, which has been certified for its chromium content using two independent analytical methods—neutron activation analysis and isotope dilution mass spectrometry. Brewers yeast was used because it is the richest known source of glucose tolerance factor, a major source of chromium in the body.

CONFERENCES

For general information on NBS conferences, contact Sara Torrence, NBS Office of Information Activities, Washington, D.C. 20234, 301/921-2721.

MATERIALS AND SPACE FLIGHT CONFERENCE

An Applications of Space Flight in Materials Science and Technology Conference will be held April 20-21, 1977, at the National Bureau of Standards, Gaithersburg, MD. The purpose is to provide a forum for a review of accomplishments of the materials processing experiments carried out in space. The meeting will also examine future opportunities for scientific materials experiments in the unique environment of the space shuttle.

The first day of the symposium will be devoted to a review of results from the NASA rocket flight experiments. The keynote address will be presented by Dr. John E. Naugle, Associate Administrator of NASA. Specific topics to be discussed during the first day sessions are in the areas of metallurgy, fluid mechanics, and crystal growth.

The second day of the symposium will focus on the optimum utilization of space flight in materials science and technology. Panel discussions will be held in order to get maximum comment from the audience. Areas to be discussed are critical phenomena and condensation, thermodynamics and purification, crystal growth, solidification, transport properties in fluid, fluid and combustion dynamics, and fluid flow and dynamics.

Contact Ronald B. Johnson, B348 Materials Building, 301/921-2835, for general information or Dr. Shirleigh Silverman, A402 Administration Building, 301/921-3814, for technical information.

THERMOPHYSICAL PROPERTIES SYMPOSIUM

Research on thermophysical properties relevant to energy problems will be highlighted at the Seventh Symposium on Thermophysical Properties May 10-12 at the National Bureau of Standards in Gaithersburg, MD. The three-day symposium is jointly sponsored by NBS and the American Society of Mechanical Engineers. As the latest in a series of meetings which began in 1959, this conference will provide a forum for presenting and discussing research activities in the thermophysical properties field.

Research on thermophysical properties relevant to energy problems will be featured in sessions on nuclear materials, liquid metals, and steam. Other properties of materials likely to be used in applications such as solar and geothermal energy.

All together, the symposium will consist of 33 sessions with more than 160 papers, including 15 invited papers on several major topics of general current interest and on reviews of thermophysical research on the international scene. Scientists from 16 countries including the United States are expected to attend.

Other major thermodynamic areas to be covered include enthalpy, heat capacity, surface tension, thermal expansion, PVT studies, critical phenomena, thermal conductivity, electrical conductivity, thermal diffusivity, mass diffusion, viscosity, and thermal radiation properties. A special session will be devoted to thermophysical properties reference data and reference materials. Studies on pure as well as on engineering materials will be reported.

The keynote speaker at the opening session on May 10 will be Dr. Yeram S. Touloukian, Professor of Engineering at Purdue University, Lafayette, Indiana. He will speak on "The Impact of Physical Properties Research on Technology Advancement."

Advance registration for the conference is requested. A registration fee of $80 is being charged to defray costs of conducting the symposium. Each registrant will receive a copy of the symposium proceedings upon its publication.

For further information contact Dr. Ared Cezairliyan, Room 124 Hazard Building, 301/921-3687 or Ronald B. Johnson, B348 Materials Building, 301/921-2835.

CONFERENCE CALENDAR

April 14-15

10TH ANNUAL SYMPOSIUM ON THE INTERFACE OF COMPUTER SCIENCE AND STATISTICS, NBS, Gaithersburg, MD; sponsored by NBS; contact: David Hogben, A338 Administration Building, 301/921-2315.

April 18-19

WORKSHOP ON THE ESTIMATION OF THE PROPERTIES OF FLUID MIXTURES, NBS, Gaithersburg, MD; sponsored by NBS; contact: Dr. Max Klein, A105 Physics Building, 301/921-2533.

April 20-21

SYMPOSIUM ON APPLICATION OF SPACE FLIGHT IN MATERIALS SCIENCE AND TECHNOLOGY, NBS, Gaithersburg, MD; sponsored by NBS and NASA; contact: Ronald B. Johnson, B348 Materials Building, 301/921-2835 or Dr. Shirleigh Silverman, A402 Administration Building, 301/921-3814.

April 23-26

COMPUTERS IN ACTIVATION ANALYSIS AND GAMMA-RAY SPECTROSCOPY, NBS, Gaithersburg, MD; sponsored by NBS, American Nuclear Society, American Chemical Society, ERDA and U. of Puerto, Rico Nuclear Center; contact: B. Stephen Carpenter, B108 Reactor Building, 301/921-2167.

April 25-28

LOW FREQENCY ELECTRICAL MEASUREMENTS SEMINAR, NBS, Gaithersburg, MD; sponsored by NBS; contact: Ronald F. Dziuba, A247 Metrology Building, 301/921-3806.

May 10-12

SEVENTH SYMPOSIUM ON THERMOPHYSICAL PROPERTIES, NBS, Gaithersburg, MD; sponsored by NBS and the American Society of Mechanical Engineers; contact: Ared Cezariliyan, Room 124, Hazard Building, 301/921-3687.

May 16-18

CONFERENCE ON CORROSION OF METAL IN BUILDINGS, NBS, Gaithersburg, MD; sponsored by NBS; contact: Dr. G. Frohnsdorff, B350 Building Research Building, 301/921-3458 or Dr. J. Kruger, B252 Materials Building, 301/921-2094.

May 17-19

MECHANICAL FAILURES PREVENTION GROUP, Illinois Institute of Technology Research Institute, Chicago, Ill., sponsored by NBS, MFPG and IITRI; contact: Harry Burnett, B260 Materials Building, 301/921-2813.

May 19

TRENDS AND APPLICATIONS SYMPOSIUM COMPUTER SECURITY AND INTEGRITY, NBS, Gaithersburg, MD; sponsored by NBS, and IEEE Computer Society; contact: Marshall Abrams, B212 Technology Building, 301/921-2601.

June 2

SYSTEMS AND SOFTWARE: OPERATIONAL RELIABILITY AND PERFORMANCE ASSURANCE; 16th Annual Technical Symposium, NBS, Gaithersburg, MD; sponsored by the Association for Computing Machinery, Washington, D.C. chapter, and NBS. Contact: Stuart Katzke, A265 Technology Building, 301/921-3861.

***June 3**

TELECOMMUNICATIONS TECHNOLOGIES, NETWORKING AND LIBRARIES, NBS, Gaithersburg, MD; sponsored by NBS; contact: Patricia Berger, E120 Administration Building, 301/921-3405.

***June 8-9**

ULTRA WORKSHOP, NBS, Gaithersburg, MD; sponsored by NBS; contact: Jack Tech, B308 Metrology Building, 301/921-3864.

****June 13-15**

CONFERENCE ON ULTRASONIC TISSUE CHARACTERIZATION, NBS, Gaithersburg, MD; sponsored by NBS; contact: Melvin Linzer, A329 Materials Building, 301/921-2858.

August 9-11 CANCELLED

FIFTH SYMPOSIUM ON THE SIMULATION OF COMPUTER SYSTEMS, NBS, Gaithersburg, MD; sponsored by NBS and the Special Interest Group on Simulation of the Association for Computing Machinery; contact: Paul Roth, B250, Technology Building, 301/921-3545.

***September 7-8**

SEMINAR ON EARTHQUAKE DESIGN CRITERIA, STRUCTURAL PERFORMANCE, AND STRONG MOTION RECORDS, NBS, Gaithersburg, MD; sponsored by NBS, EERI; contact: Dr. Richard Wright, B244 Building Research Building, 301/921-3377.

September 21-23

SYMPOSIUM ON ROOFING TECHNOLOGY, NBS, Gaithersburg, MD; sponsored by NBS and the National Roofing Contractors Association; contact: Robert G. Mathey, B348, Building Research, 301/921-3407.

September 28-30

DATA ELEMENT MANAGEMENT SYMPOSIUM, NBS, Gaithersburg, MD; sponsored by NBS and ANSI Committee X3L8; contact: Hazel McEwen, B226 Technology Building, 301/921-3157.

***October 3-6**

ALTERNATIVES FOR CADMIUM ELECTROPLATING IN METAL FINISHING, NBS, Gaithersburg, MD; sponsored by NBS, Consumer Product Safety Commission, Department of Defense, Department of Interior, Occupational Safety and Health Administration, Environmental Protection Agency, Food and Drug Administration, and General Services Administration; contact: Fielding Ogburn, B166 Polymers Building, 301/921-2957.

October 11-13

MATERIALS FOR COAL CONVERSION AND UTILIZATION, NBS, Gaithersburg, MD; sponsored by NBS, Energy Research and Development Administration, Electric Power Research Institute; contact: S. J. Schneider, B303, Materials Building, 301/921-2893.

***October 11-14**

COMPUTER PERFORMANCE EVALUATION USERS GROUP, 13TH MEETING, New Orleans, LA., sponsored by NBS; contact: Dennis Conti, A248 Technology Building, 301/921-3861.

November 1-3

MECHANICAL FAILURES PREVENTION GROUP, NBS, Gaithersburg, MD; sponsored by NBS and MFPG; contact: Harry C. Burnett, B260 Materials Building, 301/921-2818.

***November 13-17**

WORKSHOP ON RAPID SOLIDIFICATION TECHNOLOGY, Sheraton-Reston, Reston, VA; sponsored by NBS, ARPA; contact: Dr. Arthur Ruff, B264 Materials Building, 301/921-2811.

December 5-7

WINTER SIMULATION CONFERENCE, NBS, Gaithersburg, MD; sponsored by NBS, the Association for Computing Machinery, the Institute of Electrical and Electronic Engineers, Operations Research Association of America, the Institute for Industrial Engineers, and the Society for Computer Simulation; contact: Paul F. Roth, B250 Technology Building, 301/921-3545.

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* New Listing.

** This conference was originally scheduled for June 6-9.

WEIGHTS AND MEASURES STANDARDS OF THE UNITED STATES, A BRIEF HISTORY

*by L. E. Barbrow**

The title of this article is also the title of a newly revised edition of an NBS publication that is of special interest today because of the rapidly increasing use of the metric system of weights and measures in the United States.

Both the Articles of Confederation and our Constitution give to the Congress the power to coin money, regulate the value thereof, and fix the standard of weights and measures. Congress, early in our history, took action on coinage, but rarely took action to assure uniform weights and measures.

In the early days of our country, the standards for length, weight, and volume used by the various States were based on standards brought over from time to time from our mother country. There was great diversity among them. In 1828, the Congress passed an Act which specified a specific troy pound for use in setting the weight of coins of the United States. However, there was at that time no Congressional action specifically related to standards of weights and measures for everyday use.

In 1832, the Treasury Department adopted standards for the yard, pound, gallon, and bushel for use in customs houses. In 1836, the Congress directed the Secretary of the Treasury to supply complete sets of weights and measures standards to the states. By 1850, all of the states had been supplied with complete sets of weights and measures standards.

In 1866, 111 years ago, Congress legalized the metric system of weights and measures in the United States and authorized the Secretary of the Treasury to furnish the states with metric weights and measures standards. The Office of Weights and Measures of the Treasury Department used the Meter and the Kilogram of the "Archives of France" as fundamental standards. This Meter of the Archives, a platinum bar representing one 10 millionth of a quadrant of the Earth, and this Kilogram of the Archives, a platinum cylinder representing the weight of a cubic decimeter of water, had been fabricated in France in the 1790's. These two French standards were destined to become the basis of the metric system that has spread throughout the world.

In 1875, a little over 100 years ago, the United States was one of 17 nations to sign the Treaty of the Meter. International and national prototype meter bars and kilograms of platinum-iridium were constructed and calibrated in terms of the Meter and Kilogram of the Archives, under the supervision of the International Bureau of Weights and Measures that was set up in France as a result of the Treaty of the Meter. National prototypes became available to the U.S. in 1890.

Three years later, in 1893, an action of tremendous importance was taken by the Treasury Department when it issued the "Mendenhall Order." By this order, the customary weights and measures of the United States were defined in terms of the prototype meter and kilogram. Thus, insofar as standards of measurement are concerned, these metric measures became the official basis for our measurement system and have remained so ever since; the yard was defined in terms of the meter and the pound in terms of the kilogram. In addition to providing the metric base for measurement standards, the Mendenhall order included an interesting sentence regarding the law of 1866 that made the metric system legal in the United States: "This was the first general legislation upon the subject, and the metric system was thus the first, and thus far the only, system made generally legal throughout the country." That was the situation in 1893 and is a startling fact today—the metric system, which even now has relatively little use in our country compared to our customary system, is recognized by law, while our predominant customary system is recognized not by law but by custom.

The use of the metric system is now growing rapidly in the United States, particularly in the manufacturing and education sectors. Under a law enacted in December 1975, a U.S. Metric Board will soon be appointed to coordinate this increasing use of the metric system on a voluntary basis. Under a law enacted on August 21, 1974, the U.S. Office of Education has responsibility for encouraging increased teaching of the metric system in our schools.

Within the last ten years, the National Bureau of Standards has supplied to all of our states new sets of customary and metric standards of weight, length, and volume, as well as precision balances. The weights and measures officials of our states are accordingly in a position to check metric weights and measures as they increase in use in our country as efficiently as they have been checking customary weights and measures over the years.

The rapidly increasing use of the metric system makes it appear that the 70's represent the last decade for predominance of our customary system of weights and measures and that the 80's may well find the metric system becoming the predominant system of measurement in the United States.

*Barbrow is coordinator of metric activities at NBS; he updated *Weights and Measures Standards of the United States, a Brief History,* Nat. Bur. Stand. (U.S.), NBS Spec. Publ. 447, 36 pages (Mar. 1976), Stock No. 003-003-06145-3, $1.

Building Technology

Leyendecker, E. V., and Burnett, E. F. P., *The Incidence of Abnormal Loading in Residential Buildings*, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 89, 31 pages (Dec. 1976) SD Catalog No. C13.29/2:89, 75 cents.

Electromagnetic Metrology

Greene, F. M., *Measurement of Rf Power-Absorption in Biological Specimens (10 to 100 MHz)*, Nat. Bur. Stand. (U.S.), Tech. Note 687, 29 pages (Nov. 1976) SD Catalog No. C13.46:687, 75 cents.

Viezbicke, P. P., *Yagi Antenna Design*, Nat. Bur. Stand. (U.S.), Tech. Note 688, 27 pages (Dec. 1976) SD Catalog No. C13.46:688, 65 cents.

Electronic Technology

Schafft, H. A., Ed., *Semiconductor Measurement Technology: ARPA/NBS Workshop III. Test Patterns for Integrated Circuits*, Nat. Bur. Stand. (U.S.), Spec. Publ. 400-15, 52 pages (Jan. 1976) SD Catalog No. C13.10:400-15, $1.50.

Energy Conservation and Production

Hill, J. E., Streed, E. R., Kelley, G. E., Geits, J. C., and Kusuda, T., *Development of Proposed Standards for Testing Solar Collectors and Thermal Storage Devices*, Nat. Bur. Stand. (U.S.), Tech. Note 899, 265 pages (Feb. 1976) SD Catalog No. C13.46:899, $3.10.

Hord, J., *Is Hydrogen Safe?*, Nat. Bur. Stand. (U.S.) ,Tech. Note 690, 38 pages (Oct. 1976) SD Catalog No. C13.46:690, 85 cents.

Instrumentation and Experimental Methods

Heinrich, K. F. J., Newbury, D. E., and Yakowitz, H., Eds., *Use of Monte Carlo Calculations in Electron Probe Microanalysis and Scanning Electron Microscopy. Proceedings of a Workshop Held at the National Bureau of Standards, Gaithersburg, MD, Oct. 1-3, 1975*, Nat. Bur. Stand. (U.S.), Spec. Publ. 460, 169 pages (Feb. 1977) SD Catalog No. C13.10:460, $3.25.

Measurement Science and Technology Physical Standards and Fundamental Constants

Barnes, J. A., *A Simulation of the Fluctuations of International Atomic Time*, Nat. Bur. Stand. (U.S.), Tech. Note 689, 23 pages (Nov. 1976) SD Catalog No. C13.46:689, 55 cents.

Metrology: Physical Measurements

Gray, J. E., *Clock Synchronization and Comparison: Problems, Techniques and Hardware*, Nat. Bur. Stand. (U.S.), Tech. Note 691, 12 pages (Nov. 1976) SD Catalog No. C13.46:691, 35 cents.

Processing and Performance of Materials Nuclear Physics and Radiation Technology

Fivozinsky, S. P., Ed., *Measurements for the Safe Use of Radiation. Proceedings of an NBS 75th ANNIVERSARY Symposium Held at the National Bureau of Standards, Gaithersburg, MD, Mar. 1-4, 1976*, Nat. Bur. Stand. (U.S.), Spec. Publ. 456, 437 pages (Nov. 1976) SD Catalog No. C13.10:456, $5.15.

Processing and Performance of Materials

Glass, A. J., and Guenther, A. H., Eds., *Laser Induced Damage in Optical Materials: 1976. Proceedings of a Symposium Sponsored by: National Bureau of Standards, American Society for Testing and Materials, Office of Naval Research, Energy Research and Development Administration, Defense Advanced Research Project Agency, July 13-15, 1976, NBS Boulder, CO*, Nat. Bur. Stand. .U.S.), Spec. Publ. 462, 410 pages (Dec. 1976) SD Catalog No. C13.10:462, $4.60.

Rossiter, W. J., Jr., and Mathey, R. G., *The Viscosities of Roofing Asphalts at Application Temperatures*, Nat. Bur. Stand. (U.S.), Bldg. Sci. Ser. 92, 23 pages (Dec. 1976) SD Catalog No. C13.29/2:92, 70 cents.

Properties of Materials: Electronic, Magnetic, and Optical

Cezairliyan, A., and McClure, J. L., *Measurement of Melting Point and Radiance Temperature (at Melting Point and at 653 nm) of Hafnium-3 (wt. %) Zirconium by a Pulse Heating Method*, J. Res. Nat. Bur. Stand. (U.S.), 80A (Phys. and Chem.), No 4, 659-662 (July-Aug. 1976).

Surfaces and Interfaces

Franklin, A. D., Ed., *Electrocatalysis on Non-Metallic Surfaces. Proceedings of a Workshop Held at the National Bureau of Standards, Gaithersburg, MD, Dec. 9-12, 1976*, Nat. Bur. Stand. (U.S.), Spec. Publ. 455, 372 pages (Nov. 1976) SD Catalog No. C13.10:455, $4.45.

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NEWS BRIEFS

CENTER STUDIES FIRE SAFETY OF BART SYSTEM. NBS' Center for Fire Research studied the fire safety of San Francisco's Bay Area Rapid Transit System (BART) following a recent fire in a transit vehicle. NBS recommended that BART upgrade the fire resistance of seat assemblies, install a fire/smoke detection system in subway cars, and look into the feasibility of using a special fire-resistant coating on walls and ceilings of the cars. The work was performed at the request of the Department of Transportation's Urban Mass Transit Administration.

NBS SEEKS ENERGY-RELATED INVENTIONS. NBS is looking for new ways and techniques for conserving or increasing the supply of energy as part of a program to evaluate promising inventions for the Energy Research and Development Administration. Nonnuclear energy-related inventions, particularly those submitted by individuals and small businesses and companies, will be evaluated free by the NBS Office of Energy-Related Inventions. If found to have merit, the inventions may be recommended to ERDA for support. Write: Office of Energy-Related Inventions, NBS, Washington, D.C. 20234 or call 301/921-3694.

ENERGY SAVINGS IN THE KITCHEN. Many consumers could achieve significant energy savings in the kitchen if they learned to use their ranges more efficiently, according to a new NBS study. The study on consumer use of kitchen ranges was carried out at a test house in Gaithersburg, Md., as part of the Federal Energy Administration's appliance efficiency improvement program. Under the program, manufacturers will have to design appliances so that they meet energy efficiency improvement targets set by FEA for 1980.

HEAT PUMP RESEARCH IS STIRLING IDEA. A team of NBS engineers has been evaluating a Stirling engine-driven heat pump for applications in medium- to large-sized buildings. A unique kind of external combustion engine developed by Philips Corporation of Holland, the Stirling engine has minimal pollution, little noise, low maintenance, and can run on nearly any fuel. Most important, it has the highest theoretical thermal efficiency possible for heat engines. NBS is the only U.S. organization testing a Stirling engine for use in building systems.

TRIPLE NICKELS RENAMED. The proposed Voluntary Standards and Accreditation Act (S.3555) introduced in the last session of Congress has been superceded in this session by a nearly identical proposal introduced by Senator James G. Abourezk and numbered S.825. The bill would establish uniform procedures for organizations that develop voluntary industrial standards for consumer and producer goods and would set uniform procedures for organizations that certify products against those standards. Hearings are now being held in the Senate Antitrust and Monopoly Subcommittee.

NEXT MONTH IN

DIMENSIONS/NBS

Is computerized record keeping being turned into a threat against individual privacy? A Columbia University Professor studied the area of medical record keeping for NBS. His findings and recommendations are discussed in the May issue of DIMENSIONS/NBS.

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